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THE OPERATIONS OF SURGERY

INTENDED ESPECIALLY FOR THE USE OF THOSE
RECENTLY APPOINTED ON A HOSPITAL STAFF

AND FOR

THOSE PREPARING FOR THE HIGHER EXAMINATIONS

BY

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SURGERY IN THE MEDICAL SCHOOL

Fifth Edition

WITH SEVEN HUNDRED AND SEVENTY-SEVEN ILLUSTRATIONS

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OBDORMIVIT NON. MAI. MDCCCXCV

PREFACE TO THE FIFTH EDITION.

THIS book, of which the previous editions appeared in 1888, 1891, 1897, and 1902, was the outcome of a strong belief, which I have held for many years, that a work on Operative Surgery which aimed at being more comprehensive in scope and fuller in detail than those already published, would be of service to many who had recently been elected to hospital appointments, and to those who were working for the higher examinations. For these, and these only, not for those with a large surgical experience, this book is intended, and, as I have pointed out here and there, some of the recommendations made apply to those who have not a well-appointed hospital at their back.

Mr. Steward having been unable to continue the help which he gave me in the fourth edition, I have gratefully availed myself of Mr. R. P. Rowlands' services in the sections dealing with the general surgery of the abdomen; for these he has made himself entirely responsible. Mr. G. Bellingham Smith, Assistant Physician to the Gynæcological department at Guy's Hospital, has thoroughly revised and largely re-written the chapters dealing with "Operations on the Ovary and Uterus" in this and the last edition; Dr. Dakin having given this help in the third.

Of the 199 illustrations in the first edition the majority were made by Mr. C. W. Hogarth. For most of those which have since been added I am indebted, through M. Masson, the publisher, to Prof. Farabeuf's *Précis de Manuel Opératoire*; through Herren Lipsius and Tischer, of Kiel, to Prof. Esmarch's and Dr. Kowalzig's *Chirurgische Technik*; to Dr. Schröder, Dr. H. Tilley, Mr. J. Hutchinson, junr., Messrs. Watson Cheyne, C.B., Burghard, and W. A. Lane, Dr. M. R. Richardson, Mr. Handley, Prof. Warren, Dr. Bickham, and others. Mr. Rowlands and I desire also to acknowledge our indebtedness to the *Abdominal Surgery* of Mr. Greig Smith and Mr. J. Swain; to Messrs. Jessett, Paul, Mayo Robson, Moynihan, Henry Morris, Barker, Mitchell, Fullerton, Freyer, and to Drs. W. J. Mayo, Halsted, Young, Connell, Binnie, Scudder, Edebohls, Tuttle, Miss Aldrich-Blake, and many others, for their permission to make use of blocks and illustrations; and the like permission must be

gratefully acknowledged in the case of some who have passed away, such as Mr. Heath, whose offer was the more acceptable and valued because unsought, to make use of any of the illustrations in his well-known *Course of Operative Surgery*.

I am well aware that the book will, from time to time, require much alteration. This is unavoidable in a subject so progressive and changeful as Modern Surgery; it is especially unavoidable when a writer desires to do full justice to the work done by the crowd of labourers engaged in the same field at the present time. Many of the methods suggested in these pages will, later on, be rejected, but it is only by submitting novelties and suggestions to the one true test, that of Time, that we shall know how many are really worthy to survive. If my book aids in bringing about the application of this test, it will not have failed, altogether, in its purpose.

The plan of the book, with which some of my judges found fault, remains unchanged. I adopted the division by Regions deliberately, desiring that those for whom the book is intended should study the anatomy of each region at the same time as the account of the operations.

In the preface to the last edition I spoke of that being the last occasion on which I should take an active share in this book. Owing to the prospect which the future then opened out before me, I altered my mind. That prospect was taken from me in March, 1905. For the sake of occupation of mind, I have been glad to go on with my share of the revision of this edition. Hereafter, if further editions be called for, the pen that is responsible will be in other hands.

It remains for me to acknowledge, very gratefully, the encouragement given me by my reviewers and a host of correspondents from all parts of the world. I only wish that my book deserved better the kind things that very many have written of it. I trust that this edition will be found to give proof of the two main objects which I have ever tried to keep before me—to do justice to the work of others and to lessen, in a measure, the difficulties through which I have passed myself.

W. H. A. JACOBSON.

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PART I.

OPERATIONS ON THE UPPER EXTREMITY.

CHAPTER I.

OPERATIONS ON THE HAND.

AMPUTATION OF THE FINGERS.

Practical Anatomical Points.—I. POSITION OF THE JOINTS (Fig. 1).—This has to be remembered—(a) in front, (β) behind.

(a) *In front.*—Three sets of creases correspond here, though not exactly to the joints. Of these, the lowest crease is just above the

FIG. 1.



(Farabeuf.)

joint; the middle is opposite to the inter-phalangeal joint; the highest, nearly $\frac{3}{4}$ inch below the metacarpo-phalangeal joint.

(β) *Behind.*—It is to be remembered here (1) that in each case it is the upper bone which forms the prominence—viz., the knuckle is formed by the head of the metacarpal bone, the inter-phalangeal prominence by the head of the first phalanx, and the distal one by the head of the second; (2) that the joint in each case lies below the prominence, the distal joint being $\frac{1}{12}$ inch, the inter-phalangeal $\frac{1}{8}$ inch, and the metacarpo-phalangeal joint about $\frac{1}{3}$ inch below.*

II. SHAPE OF THE JOINTS.—In the distal and the inter-phalangeal the joint is concave from side to side, and presents a concavity towards

* The terms "above" and "below" mean nearer to and farther from the trunk.

the tips: in the metacarpo-phalangeal joint, on the other hand, the convexity is towards the finger-tips.

III. THE THECA.—This fibrous tunnel, running down to the bases of the distal phalanges and upwards to the palm, gapes widely after section. From the readiness with which the tendons conduct infection into the forearm itself, care should be taken to keep even such a small amputation as that of a finger strictly sterile. An amputation through damaged parts should be dressed with boracic acid fomentations at first, and such flaps should not be too closely united with sutures, so as to allow for tension and to provide drainage.

Operations for Amputation of the Fingers.—As one fixed method is rarely available, and as the rule here to remove as little as possible is unalterable, several should be practised, including among them the following four, of which the first two are the best—viz.:

1. Long palmar flap (Figs. 2, 5 and 6).
2. Long palmar and short dorsal flap (Fig. 7).
3. Two lateral flaps (Figs. 4 and 7). These may be (a) equal, (β) unequal.
4. One long lateral flap.
5. Two equal antero-posterior flaps.*

Of these, the palmar flap is usually the one made use of. Though, as the hands are by far most frequently placed in the prone position, a dorsal flap falls more easily into place, and gives a more concealed scar, a palmar flap has the greater advantages of a scar which is not pressed upon when anything is held in the hand, of possessing finer sensitiveness in touch and better nutrition; furthermore, this flap is available even in the last phalanx, where, from the presence of the nail, a dorsal flap is not obtainable (Fig. 2).

Amputation of a Distal Phalanx by a Palmar Flap (Fig. 2).

—**First Method.**—The hand being pronated, a strip of sterilised gauze wound round the phalanx so as to give a firm grip,† and the adjacent fingers well flexed, the surgeon, having placed his left forefinger just below and behind the joint, and flexed the phalanx strongly with his thumb (a step not always easy with infiltrated tissues), cuts,‡ with a slightly semilunar sweep, and drawing the blade from heel to toe, straight into the joint. To effect this neatly, the convexity of the sweep should pass $\frac{1}{2}$ inch below the prominence or angle produced by flexion, the sweep being made by laying on the whole edge of the knife, while with the point, as this incision begins and ends, the lateral ligaments are partly cut. The joint being thus freely opened, the knife is

FIG. 2.



* These will produce a stump with an exposed scar.

† In the drawing this is left out for the sake of distinctness.

‡ The knife in all these finger amputations should be narrow, short, and slender, yet strong (Figs. 2 and 6).

insinuated behind the base of the phalanx (a step which is facilitated by depressing and pulling on the phalanx), and then, being kept close to, and parallel with, the bone, cuts, with a steady sawing movement, a flap well rounded at its extremity, about two-thirds in length of the pulp of the finger.*

Second Method.—The hand being supinated, the finger to be operated on extended, and the others flexed out of the way, a palmar flap is cut by transfixion, the knife being entered just below the palmar crease, the joint being then opened from the dorsum as before, and the phalanx lastly disarticulated. If transfixion be made use of, the following comment of Sir F. Treves (*Oper. Surg.*, vol. i. p. 308) must be remembered: "In no operation upon the fingers is it well to cut the flaps by transfixion. In cutting a palmar flap by this means there is danger of slitting up the digital arteries. The flap, moreover, is apt to be pointed and scanty, and to contain fragments of tendon."

Third Method.—If the surgeon has no narrow knife by him, he may modify the last method by cutting his palmar flap first, but from without inwards; he then opens the joint from the dorsum, and disarticulates.

As a rule, no vessels require ligature. Any tendon that is jagged should be cut square.

Difficulties and Mistakes in Amputation of a Distal Phalanx.—

(1) The flap may, of course, be made too short; it is often made too pointed. I would take this opportunity of reminding my younger readers that as the long bones of the hand are large in relation to their soft parts, the flap or flaps should always be cut sufficiently long. The student must in this, his first amputation, fix upon his mind a rule which must be followed in all amputations, large or small—to measure with the eye whether the flap or flaps will be sufficient, just before the flap is finally cut. (2) If the phalanx be not sufficiently flexed, or if the site of the joint has not first been marked out with the nail, the latter will not be readily opened. It is very common for students, forgetting that in the case of each joint this lies below the corresponding prominence (Fig. 1), to cut above the level of the joint here, their knife sawing against the neck or head of the second phalanx. (3) It is often difficult to pass the knife readily behind the base of the phalanx, especially in cases where the blade is too broad, or where, as in well-developed hands, the base of the phalanx is strongly tuberculated. (4) If there be any hitch in passing the knife behind the phalanx, the outline of the flap is very likely to be jagged, and to cause sloughing.

Amputation of the Second Phalanx (Figs. 4 and 5).—

This, as a rule, should be performed through the phalanx, and, whenever this is possible, beyond its centre, so as to leave the upper half or third of the phalanx, and thus ensure some attachment of the flexor sublimis being preserved.

While the rule not to amputate a finger at the joint between the first and second phalanges, and *à fortiori* through the first phalanx, is

* If the flap is insufficient, the head of the second phalanx must be removed. In this and in other amputations in the hand, owing to the soft parts cut through being often infiltrated and fixed, the flaps are easily made too short, from the desire of the surgeon to leave as much as possible.

a sound one, as there is a risk of leaving a stump stiff and incapable of flexion, there is no doubt whatever that, where rapid healing has been secured, the above amputation has been followed by the flexor tendon taking on a fresh and sufficiently firm adhesion, and so leaving a longer and, withal, a mobile stump.

In the following special cases the whole or part of the first phalanx may be left, and in all of them the severed flexor tendons, previously cut long, should be carefully stitched with sterilised silk to the cut theca and periosteum, or into the flaps before these are adjusted. Another plan is to suture together the flexor and extensor tendons (cut long and square) over the end of the bone (Waring).

(1) In the case of the index finger the proximal phalanx will be a useful opponent to the thumb, as in holding a pen. (2) In the case of the little finger, leaving the proximal phalanx will give greater symmetry to the hand when this is flexed, and it should accordingly be left, if the patient desire it. (3) In amputation of all the fingers, the proximal phalanx of one should, if possible, always be left to oppose to the thumb. (4) Where a patient insists on having the proximal phalanx left, after the risk of stiffness has been explained to him. The more care is taken to fix the severed flexors to the theca or extensors, the more quickly the stump heals, and the younger the patient, the greater will be the movement gained.*

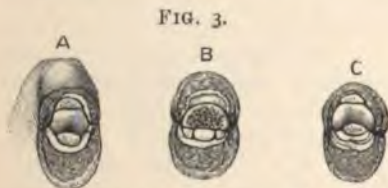


FIG. 3.
A. Flaps after amputation of terminal phalanx. B. Flaps after amputation through second phalanx. C. Amputation of second phalanx (Heath). In each case antero-posterior flaps have been made. In B the flexor tendon, and in C both flexor and extensor tendons, should be sutured as directed above, having been first cut long.



FIG. 4.

Different methods for partial removal of the fingers. In the index, two rounded lateral flaps; in the middle finger, two square dorsal and palmar; in the case of the ring finger, two rounded flaps, dorsal and palmar; and in the little finger, a single dorsal flap, are shown. (Farabeuf.)

Amputation through, or Disarticulation of, the Middle Phalanx.

(1) By a Long Palmar or Dorsal Flap (Figs. 5 and 6), or by Dorso-palmar Flaps, the flaps being equal, or the palmar one the longer (Figs. 4 and 7).

* Dr. Tiffany, of Baltimore (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 826), says that he has been in the habit "for a number of years" of passing the stitches which unite the skin through the tendons and their sheaths in amputation at the joint between the first and second phalanges. "I have never failed, as far as I can remember, to secure quite as good movement as if Nature had originally made an attachment there for these tendons."

By Dorso-palmar Flaps.—The surgeon, having marked with his left forefinger and thumb* the spot where he intends to divide the bone, cuts between these points a short, well-rounded dorsal flap of skin; he then sends his knife across below the bone, making it enter and emerge at the base of the first flap, and cuts a palmar flap about $\frac{2}{3}$ inch in length, and not pointed. The flaps are then retracted,

FIG. 5.



Amputation through the inter-phalangeal joint by a long palmar flap, the joint being opened first. (Fergusson.)

FIG. 6.



Amputation through the second phalanx by a long palmar flap, this being made first by transfixion. (Fergusson.)

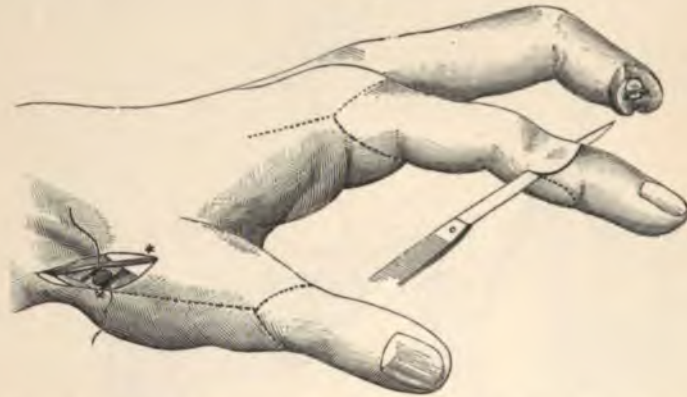
the bone cleared with a circular sweep of the knife, and divided in the manner given below.

By Lateral Flaps (Figs. 4 and 7).—The site where the bone is to be sawn having been marked by the left forefinger and thumb placed on the dorsal and palmar aspects of the finger at this level, the surgeon, looking over the finger, enters his knife in the centre of the palmar

* These are left out of the drawings for the sake of distinctness.

aspect, and carries it, cutting an oval flap, about $\frac{1}{2}$ inch in length, to a corresponding point on the centre of the dorsum, and then from this point down again over the side of the finger nearest to him, to the point where the knife was first inserted. The flaps being dissected up as thick as possible, and the remaining soft parts severed with a circular sweep, the bone is divided with saw or bone-forceps. If necessary, one flap can be cut longer than the other. In using the bone-forceps the concave surface is always to be turned away from the

FIG. 7.



In the second finger, amputation through the second phalanx by lateral flaps is shown. The bone has been divided below the insertion of the flexor sublimis; if there were any doubt about this, the tendon would be stitched to the theca and flaps, as advised at p. 4. In the index finger, amputation through the second phalanx by short dorsal and long palmar flaps is figured. The left finger and thumb of the surgeon, which would mark the base of the flaps, are left out for the sake of distinctness. The flaps for amputation of the index finger at the metacarpophalangeal joint are also shown, the straight part of the incision being placed rather to the radial side of the head of the metacarpal bone. The scar would be better hidden if the incision had been placed on the ulnar side (p. 9).

In the thumb, the flaps for amputation at the carpo-metacarpal joint are indicated. The two * * show where the radial artery may be wounded, near the joint, and in the interosseous space, in this amputation (p. 12).

Ligature of the radial artery at the back of the wrist is also represented. The radial vein crosses the wound from angle to angle. The artery, with the ligature under it, is shown between the extensor ossis metacarpi and extensor primi internodii in the lower angle, and the extensor secundi internodii in the upper angle of the wound (p. 83).

trunk; if this precaution is taken, and the bones severed quickly with a sharp instrument, the section will be clean, and not crushed. But a fine saw is much the better instrument.

Amputation of a Finger, e.g., Second or Third, at the Metacarpophalangeal Joint (Figs. 7, 8, 9 and 10).—This, the commonest amputation in the hand, being required for severe crushes, tubercular disease, and some cases of whitlow, should be often practised. Before it is employed for an injury, the remarks on The Conservative Surgery of the Hand (p. 16) should be consulted. It is usually performed by the modified oval method, the *en raquette* of

Malgaigne. Lateral flaps I consider better. Other methods, to be used according to the condition of the soft parts, are shown below (Fig. 10).

The hand having been pronated, the radial and ulnar arteries commanded by an Esmarch's bandage or the fingers of an assistant above the wrist, some sterilised gauze wrapped round the damaged finger, and the adjacent ones flexed out of the way or held aside with strips of sterilised gauze, the point of the knife is inserted $\frac{3}{4}$ inch above the head of the metacarpal bone, sunk down to the bone itself, and then carried down in the middle line till it gets well on to the base of the phalanx; then, diverging to one side, the knife is carried obliquely below the web* across the palmar aspect of the first phalanx below the palm, and then around the other side of the phalanx (also below the web) so as to join the straight part of the incision which lies over the head of the metacarpal bone.

Lateral Flaps (Fig. 10).—In practice, especially in the country, where an anæsthetic is not always easily available, it is much preferable, because quicker, to make two separate incisions, each beginning $\frac{3}{4}$ inch above the head of the metacarpal bone, and meeting again on the centre of the base of the palmar aspect of the first phalanx, well below the palm, instead of carrying the knife continuously round the finger. This method is not only quicker,† but it does not leave, as in the first method, a small tongue of tissue on the palmar aspect, which is a little difficult to adjust satisfactorily, and behind which discharges may collect.

Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii. p. 249) point out that where any such projection is present, as in a working man's hand with a very thick palmar skin, the removal of a V-shaped portion here, after the completion of the amputation, will cause the entire disappearance of the projection.

Whether the method by lateral flaps or *en raquette* be employed, the knife should be used boldly, the extensor tendon severed in the first incision over the head of the metacarpal bone, and the soft parts at the sides cut to the bone. Then, the finger being now extended, one lip of the cut tissue is taken up with the finger and thumb, the flaps are dissected up as thick as possible, tendons cut clean and square, the lateral and anterior ligaments severed with the point of the knife, and the joint opened by retraction of its site well below the projecting

FIG. 8.



Incisions for amputation at the metacarpo-phalangeal joint. If the metacarpal bone requires removal as well, the apex of the incision would be prolonged upwards. (Fergusson.)

* Cutting into the web will lead to much more hæmorrhage, too short flaps unless the head of the bone is removed, and increase of pain in healing.

† Because it avoids the hitch usually met with in carrying the knife around the base of one finger between two others.

knuckle (p. 1, Fig. 1). Disarticulation will be facilitated by twisting the finger, first to one side, and then to the other, so as to render tight the parts which remain to be cut. On no account should the knife needlessly enter the palm. This will only lead to troublesome bleeding, especially in inflamed parts, and, perhaps, to the spreading of infective inflammation.

A caution may be given here which applies to all amputations but especially to those performed for accidents, where there may not have been time to secure absolute sterilisation of the parts concerned. It is very easy for the tendons, when they are drawn down in order that they may be cut short and square, to carry up infection as they retract into

FIG. 9.



Amputation of the middle finger by lateral flaps (Heath). The neck of the bone should be more fully cleaned, the tendons separated, and the bite of the forceps pressed more securely round the neck of the bone.

their sheaths. At this stage especially it is important to use some efficient antiseptic irrigation, such as lysol.

Where strength has to be considered rather than appearance, the head of the metacarpal bone should be left, whatever be the rank in life of the patient, as the transverse ligament is thus less interfered with, the hand less weakened, and the palm not opened up. But where appearance is the most important point, and the mutilation is to be hidden as much as possible by the approximation of the fingers, the head of the bone should be removed by a narrow-bladed saw or by bone-forceps* (Fig. 9). In either case the section should be made obliquely from above downwards and from behind forwards, so as to remove more on the dorsal than the palmar aspect. In such cases, after a little practice, it is not necessary to perform disarticulation, the metacarpal bone being

* With the precautions given at p. 6. A saw, avoiding splintering, is preferable.

severed after the flaps have been dissected upwards to the proper level. Here, too, care must be scrupulously taken not to interfere with the tissues in the palm.

After removal of the finger and the Esmarch's bandage, one or more digital vessels will require ligature, lying rather deeply opposite the web of the finger.*

In the case of the thumb, index (Figs. 7 and 10) or little finger, the straight part of the oval incision should be placed to the ulnar side of the metacarpal bone, rather than in the dorsal mid-line, as the line of incision will be better concealed. In these cases the saw or bone-forceps should be applied obliquely from without inwards and from

FIG. 10.



Different methods of amputating the thumb and fingers at their metacarpophalangeal joints. In the case of the thumb a long palmar flap has been made; in the index a palmar and external flap; in the middle finger a circular incision and a straight dorsal cut (a modification of the method *en raquette*) have been employed; the ring finger has been removed by two lateral flaps, and the little one by an internal and palmar flap. (Farabeuf.)

within outwards respectively, so as to leave no projecting bone on the radial or ulnar aspect of the hand, and, in the case of the index, to allow of the thumb being readily approximated to the second finger.

It may be worth while to add the following hints with regard to the after-treatment—(1) Not to bandage the adjacent fingers too closely or too long together, otherwise a tendency to cross at their points will be noticed later on. (2) In this and all other disarticulations where, in spite

* Care should be taken to secure these vessels, especially where they are enlarged in any inflammatory condition, otherwise profuse bleeding may take place a few hours after the operation.

of copious irrigation with sterile saline or other solution, a coexisting infective condition cannot be got rid of with certainty, the cartilage should be removed. Tedious exfoliation is, otherwise, certain. As already advised, there should be no close suturing in these cases, and boracic acid fomentations should be employed at first. In this and many other amputations of the hand, perforated zinc, which can be easily boiled when needed, is the best material for splints.

Disarticulation by a Circular Incision with a Straight One on the Dorsum (Fig. 10).—This method, a modification of the one *en raquette*, is preferred by Farabeuf as simpler and sacrificing less skin. The hand being completely supinated, and the other fingers bent out of the way, the surgeon cuts across the root of the finger in the digito-palmar fold, going down to the bone, and encroaching as far as possible on the sides of the finger. The hand being pronated, the ends of the circular incision are prolonged up to the middle line of the dorsal aspect of the finger, where a straight cut, beginning a little above the level of the joint, is drawn down to and perpendicular to the first. By this means, two right-angled flaps are marked out. These are raised, and the bone disarticulated, by the steps already given.

Amputation by a Single Flap.—Where, owing to the state of the soft parts, this method is required, Fig. 10 shows how it may be employed.

Amputation of a Finger, together with Removal (complete or partial) of its Metacarpal Bone.—This operation is easily performed by a modification of the method *en raquette* or that by lateral flaps just described. It is only needful to prolong the dorsal part of the former incision or the apex of the latter as far as the carpo-metacarpal joint. Disarticulation, when the parts are much swollen, will be safely performed here by carefully prolonging back the dorsal incision in a wound kept bloodless till the joint is felt and seen, suitably manipulating the finger so as to put the structures attached to the metacarpal bone on the stretch, remembering the insertion of tendons into some of these bones, severing the ligaments of the articulations with careful touches of the knife, and not sinking this into the palm for fear of wounding the palmar synovial sac or the deep palmar arch. Wherever possible, the extensor tendons should be drawn aside and carefully preserved. In infected cases, the greatest care must be taken—*e.g.*, irrigation with sterile saline solution, application of pure carbolic acid, &c.—when a carpo-metacarpal joint is opened. Where a metacarpal bone is removed for such a disease as sarcoma, Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii. p. 152) advise that the adjacent bones on one or both sides be removed as well, to avoid the risk of leaving disease behind. They add: "When more than one metacarpal bone is removed, it is well to take away at least one finger in order to preserve the full use of the hand. Unless this be done the fingers are apt to be crowded together as the wound contracts, and considerable interference with their usefulness may ensue."

In the case of the little finger the ulnar border should be chosen for the incision, or, if the dorsal tissues are much damaged, a palmar and internal flap may be made. In clearing the metacarpal bone the knife-point must be kept very close to the bone. If only a portion of the

bone needs removal, this should be divided with a saw and not bone-forceps. Farabeuf gives the very practical hint that primary union should be secured by the flaps meeting readily. Otherwise the contraction of the scar will drag upon the next surviving finger, and cause it to stick out from its fellows in a very ugly fashion.

Amputation of Two or Three Contiguous Fingers.—When (a very rare contingency) two or more fingers require removal at the same level—*i.e.*, through their metacarpophalangeal joints, or higher up—the modified racquet or lateral flaps may again be employed, the apex of the dorsal incision starting between the fingers when two, and over the central metacarpal bone when three fingers have to be removed.

FIG. II.



Removal of little finger and its metacarpal bone by the oval method. Care has been taken not to cut into the web. Amputation of the wrist by antero-posterior flaps is also shown. (Heath.)

AMPUTATION OF THE THUMB.

Amputation of Phalanges of Thumb.—

Very little need be said about this operation, as it is very rarely performed. Owing to its numerous muscles, the thumb is extremely mobile, and thus escapes injury. Thanks to its abundant vascular supply, trimming of the soft parts after an injury will generally leave more of the thumb to oppose to the fingers than any set operation.

In cases of necrosis after whitlow, I have twice removed both phalanges, the soft parts consolidating usefully* with the aid of the periosteum that was left. For further remarks on preserving the thumb, see Excision of the Thumb, p. 13.

Operation.—Amputation of the phalanges of the thumb may be performed, in the case of the distal one, by a long palmar flap, as in the case of a finger (Figs. 2, 5, and 10); in the case of the first phalanx, by antero-posterior, lateral, or a modification of the oval method. In the last case, if the incision be begun on the radial, and not upon the dorsal aspect, less damage will be done to the tendons. In any case the incisions should be carried well on to the phalanx to ensure sufficient flaps to cover the head of the metacarpal bone, together with the sesamoid bones, which should never be removed.

The line of the metacarpophalangeal joint is very nearly transverse, and lies just in front of the knuckle.

After amputation of, or through, the phalanges, the severed end of the long flexor, previously cut long, should be carefully stitched into the angle of the flaps and to the extensor, and into the theca and periosteum as well, if possible.

* This is strongly indicated in those cases where it is especially important to leave the thumb long for holding a pen or any delicate instrument.

Amputation of the Thumb at the Carpo-metacarpal Joint (Figs. 7 and 12).

Indications.—This operation is rarely called for on the living subject.* Gunshot injuries, some growths of the phalanges and metacarpal bone (see below, p. 13), epithelioma of a scar, and melanotic sarcoma, occasionally call for it.

Operation.—The position of the joint between the trapezium and metacarpal bone, its shape, with two saddle-like articular surfaces fitting into each other "by reciprocal reception," and the position of the radial artery passing over the back of the styloid process just above this joint (Figs. 7 and 52), and again, when perforating the first interosseous space, lying close to the metacarpal bone, must be remembered.

The operation is usually performed by the oval method (Fig. 7).

An Esmarch's bandage having been applied above the wrist, the hand held midway between pronation and supination, and the thumb held over-extended so as to relax the parts, the surgeon inserts the point of a strong narrow scalpel or bistoury just above the joint. This lies a full finger's-breadth below the tip of the styloid process. Its position can usually be made out by tracing up the metacarpal bone with one finger along its inner, and the thumb along its outer margin, the thumb being alternately abducted and adducted. The knife, entering between the tendons of the extensor ossis and primi internodii, should avoid *la tabatière anatomique* (p. 82) and the radial artery. Where there is much swelling comparison must be made with the sound thumb. The incision is then carried along the dorsum of the bone as far as the base of the first phalanx, where it passes (in the case of the left thumb) obliquely to the ulnar side above the web, and then around the palmar aspect of the phalanx, along the radial side, to join the dorsal incision again. Taking up first one edge of the incision and then the other, the

surgeon dissects up the soft parts from the bone, keeping the knife-point very close to this, especially on the inner side. The extensor tendons and the short muscles of the thumb being severed, the joint between the trapezium and metacarpal bone is felt for and opened from behind, the whole thumb being strongly flexed into the palm: the thumb is now removed by putting the remaining tissues on the stretch by twisting the metacarpal bone in different directions.

Amputation of the Thumb at the Carpo-metacarpal Joint by Transfixion (Fig. 12).—The hand being held as before, and the parts relaxed by slightly adducting the thumb, an incision is made (in the case of the left thumb) from the base of the metacarpal bone rather to its palmar aspect, along its dorsum, and then obliquely to the ulnar

FIG. 12.



* It is not unfrequently used as an examination-test.

side of the base of the first phalanx; the knife, a long narrow bistoury, is then pushed from this point, at the junction of the web with the thumb, across the palmar aspect of the thumb, to the point where the incision started, over the carpo-metacarpal joint. By cutting outwards, along the line indicated in Fig. 12, a flap is formed of the tissues in the ball of the thumb, the knife being kept close to the bone at first, but used more lightly and kept more superficial afterwards, as it comes out through the skin over the sesamoid bones and base of the first phalanx, to prevent its being locked here. This flap being held back, the metacarpal bone is dissected out by keeping the knife close to it, the joint opened, and the thumb removed as before.

On the right side, it is better to cut the palmar flap by transfixion first, making it enter and emerge just as is given above. The blade of the knife is then drawn from the base of the first phalanx obliquely across the dorsum of the metacarpal bone, from one extremity of the transfixion incision to the other. The operation is then completed as before.

Whatever method is employed, the radial artery should not be seen; only its digital branches should require ligature.

In practice, total removal of the thumb is one of the rarest amputations. Part of the metacarpal bone should always be left, if possible. Even if stiff, it will be most useful when the fingers are opposed to it. The long flexor should always be sutured as advised at p. 4.

PARTIAL EXCISION OF THE THUMB.

Removal of Phalanges.—Owing to the exceeding value of the thumb, a phalanx should always be preserved, if possible, not only in whitlow-necrosis, but in the case of the first or proximal phalanx when it is the seat of enchondroma. By this, not only is appearance saved by the lessened shortening, but the use of the long flexor, in particular, is preserved.

Mr. Royes Bell (*Lancet*, 1872, vol. ii. p. 846) published a case in which he excised the proximal phalanx in a woman, aged 19, for a huge enchondroma of sixteen years' growth, the joints being movable. The phalanx was excised by two semilunar incisions over the tumour, the knife kept close to the bone, and the joints opened. No tendons were cut. Eighteen months later the condition of the thumb was excellent, both for all general movements and for writing.

In 1897 I performed a like operation on a patient aged 33. The first phalanx of the right thumb was removed, by a single dorsal incision, for an enchondroma of twelve years' standing, and the base of the distal one resected for a similar, but much smaller, growth. The long flexor was stitched to the portion of the distal phalanx left. The thumb was put up in a perforated zinc splint. Healing was complete in three weeks; active and passive movements were then assiduously begun. When I last saw the patient, six months after the operation, the thumb was much shortened and also somewhat weaker than its fellow, but it was steadily gaining in strength and usefulness, and its movements were almost completely restored.

Removal of Metacarpal Bone.—This should always be excised, wherever possible, in preference to sacrificing a part of such incalculable value as the thumb.

Sir W. Fergusson (*Pract. Surg.*, p. 322), in speaking of this operation, says that he saw it once performed, and, though the member was far from strong, the patient could use a needle with tolerable facility afterwards, and he further remarks that the comparative shortness of the bone removed, and the firm cushion of soft parts that remains after its excision, will make the remaining part useful.

A straight incision, which reaches $\frac{1}{4}$ inch beyond each extremity of the bone, having been made along the dorsum, the tendons are drawn aside ; the distal end and joint are next cleared and opened, when the bone can be used as a lever whilst it is freed from the soft parts on the palmar aspect and then disarticulated. Removal of this, as with the other metacarpals, is sometimes facilitated by dividing the bone in the centre and removing it in two pieces. In young subjects the epiphysis, if healthy, should be left. If possible, the periosteum should always be preserved.

The radial artery must be remembered both on the ulnar side of the metacarpal bone and at the carpo-metacarpal joint (Figs. 7 and 52).

EXCISION OF THE FINGERS.

Only excision of joints need be alluded to here, as, save in the case of removal of the distal phalanx (or the last two in the case of the index) for necrosis, excision of a phalanx leaves a very useless finger.

Excision of Thumb and Finger at the Metacarpo-phalangeal Joint. Reduction of Dislocations here.—The difficulty often met with in reducing a metacarpo-phalangeal dislocation in the case of the thumb has long been recognised. Mr. Battle has shown with instructive cases (*Lancet*, 1888, vol. ii. pp. 1222, 1271) that like difficulty, due to similar causes, may be met with in the case of the finger, especially the index. Other papers by the late Mr. Davies Colley and Mr. Symonds (*Lancet*, 1888, vol. i. p. 522) and Mr. Jordan Lloyd (*Lancet*, 1892, vol. i. p. 469) will repay perusal. While many different causes of the above difficulty must be remembered, viz., the buttonhole-like slit with which the two heads of the flexor brevis and their sesamoid bones now, in their altered relations, embrace the head of the metacarpal bone ; the lateral ligaments ; the interposition of the glenoid or anterior ligament between the base of the phalanx and head of the metacarpal ; the contraction of the numerous muscles around the dislocation ; the shortness of the leverage afforded by the dislocated bones, and, occasionally, a displaced long flexor tendon,*—while all these must be remembered, the chief cause of the difficulty is the displacement of the glenoid ligament. This, in reality a fibro-cartilaginous plate, occupies the interval between the lateral ligaments on the palmar aspect of each joint, and is firmly united to the phalanx but loosely to the metacarpal bone. It is continuous at each side with the lateral ligaments, so that the three form an undivided structure which covers the joint except on the dorsal aspect. As the weakest attachment of the glenoid ligament is to the metacarpal bone, it is here that

* In a case of Mr. Turner's (*Clin. Soc. Trans.*, vol. xxi. p. 170) it was a very tense long flexor, which had slipped to the inner side of the metacarpal bone, and thus prevented reduction until pulled up with a blunt hook. Mr. J. C. Wordsworth long ago (*Lancet*, 1863, vol. ii. p. 443) published a case showing that the difficulty in reduction of this dislocation was sometimes due to displacement of the long flexor tendon. MM. Duplay and Reclus (*Traité de Chirurgie*, t. iii. Fig. 133) illustrate this from a specimen of M. Farabeuf's (*Bull. de la Soc. de Chir.*, 1878, p. 457), which shows extremely well the head of the metacarpal caught between the outer head of the flexor brevis on the one side, and the long flexor and the inner head of the flexor brevis on the other.

the ligament gives way when dislocation occurs in violent hyper-extension of the joint, the displaced phalanx carrying the ligament with it over the head of the metacarpal bone.

Assuming that the anterior and lateral ligaments—one structure—with the sesamoid bones in the flexor brevis form the chief impediment to reduction, manipulation should be tried first, and always with an anæsthetic if possible. In the case of the finger, the displaced phalanx is well tilted back on to the dorsum of the metacarpal, in order to bring the glenoid and other structures already mentioned well in front of the anterior margin of the articular surface of the phalanx before flexion is employed. This, with firm pressure of the thumbs against the base of the displaced phalanx, generally causes it to slip into place. In the case of the thumb, reduction by Fabri's method should be tried on the same lines as those already given, the whole thumb being first adducted towards the palm.

If the above fail, a tenotome* should be introduced on either side of the extensor tendons about a quarter of an inch behind the articular surface of the phalanx, the bones being extended, and the two heads of the flexor brevis divided together with the glenoid ligament which is displaced and lying on the dorsum of the articular end of the metacarpal bone. Reduction will then probably be effected by flexion, extension, and rotation. The punctures are closed with collodion, and the joint put up flexed on a perforated zinc splint. Movements should be begun, according to the amount of tenderness and swelling, within five or six days. If the above fail, an incision, $1\frac{1}{2}$ inches long, should be made to the radial side of the dorsum of the joint. The want of room and the close connection of the extensor tendons with the capsule always render this small operation one of some difficulty. By a sufficiently free dorsal incision, the extensor tendon is easily separated from the bones beneath and held aside with a strabismus hook or hooked probe.

When the joint is opened, any tight bands, whether of the lateral or the transverse fibres uniting the sesamoid bones, and corresponding to the glenoid ligament or the flexor brevis, are divided or displaced. If the flexor tendon be the cause it is replaced with a strabismus hook. If more is required, the soft parts are freely retracted, and the ends of the displaced metacarpal bones having been cleared by keeping the knife-point closely applied to them, sufficient is then removed *in situ* by a narrow saw, which is preferable to bone-forceps. Free resection of one bone will probably suffice, if sufficiently free; merely paring off the articular cartilage is likely to lead to a stiff joint. Only if, owing to the amount of matting, or previous inflammation, there be additional risk of ankylosis, should the base of the first phalanx be removed as well. Care must be taken, before this is done, to detach carefully, as completely as possible, the tendons inserted into it, together with the periosteum, and where two freshly sawn surfaces are left additional precautions must be taken against ankylosis. Any tendon accidentally cut should be sutured. Drainage should be provided with sterilised horsehair. The patient must be prepared for some shortening, especially if an epiphysis has been removed.

* The tenotome should be strong as well as narrow, as there is difficulty in manipulating it between the displaced articular surfaces.

Excision of an inter-phalangeal joint may be required in some very rare cases of "snapping" or "clasp-knife finger," where the trouble is believed to be due to irregularity of the joint surfaces (p. 34). Also in those cases of congenital contraction of the finger (p. 34) where the lateral ligaments are much shortened. At p. 35 I have pointed out that, in some cases of needles deeply situated in the palm, a dorsal incision and partial removal of a metacarpal bone affords the best way of getting at the foreign body.

CONSERVATIVE SURGERY OF THE HAND.

While every case must be decided by itself, I trust that the following may be of service to my younger readers when called upon, suddenly, to form what is one of the most important decisions in all surgery.

i. **The question of trying to unite a totally separated part** is alluded to at p. 23. The question of palmar hæmorrhage is considered at p. 35; and the treatment of injuries to tendons and nerves will be found under these headings respectively.

ii. Save in the very rarest cases, where the combined comminution of bone, injury to tendons, and stripping off of skin is extreme, no **set amputation** is to be performed. In the case of a part of such incalculable value, and so well supplied with blood as the hand, the surgeon should remember Verneuil's words and not "approach these cases with the bistoury." He is to render the parts as thoroughly aseptic as possible (p. 19), and then to wait and see what Nature will do towards **the ultimate restoration of usefulness**. This, of course, entails risks of suppuration, sloughing, and even worse ones, such as tetanus. Assiduous attention to the advice at p. 19 alone justifies running these risks.

Speaking generally, these cases, in which the decision has to be made between too conservative surgery and in removing too much, fall into two groups. **A. Injuries limited to the fingers.**—Here conservative surgery is less rigidly indicated than in complicated and extensive injuries to the hand. If the injury to the finger, especially the third or fourth, be such that useful function will be lost, it will be wiser to amputate it, and not hold out any hopes of usefulness, which will only prove illusive. If it be the index which is most damaged, the surgeon will remember that a freely movable middle finger will steadily improve in sharing with the thumb the loss of the index. And if the head of the metacarpal bone has been removed, a new interdigital space will gradually be developed, which may be very useful for a working man. **B. Complicated and extensive injuries to the hand.**—Here the difficulty of estimating the extent of the damage, the power of ultimate recovery in a part like the hand, and the amount of loss of function, together with the hopelessness of any really useful artificial substitute, should make conservative surgery the rule, and the surgeon should wait and see how much antiseptic baths and dressings, together with the other aids given below, will save from destruction.

iii. **Later amputation.**—But while it is a cardinal principle to preserve every inch of the hand, a single finger or a thumb alone being far more useful than the most elaborate artificial limb that can

be made, and while to gain this end it is frequently advisable to trim up an injured part and to remove bone in preference to doing any set amputation, it must always be remembered that a part may be capable of being saved, and yet ultimately be useless, unless it be at least partially movable. Again, atrophy of a part, at first promising in usefulness, may set in some time after the injury, brought about largely by trophic disturbances. In either of these cases a rigid cicatricially contracted claw, or a pointed, sensitive, and shrunken part may call, later on, for amputation.

iv. Amongst the very exceptional cases which call for primary amputation are those where (1) one or more fingers are mangled and pulped out of all shape or recognition; (2) where all the tendons are torn through, especially if this has happened at more than one place, as in the fingers and in the palm also, and where, with these injuries, there is much opening of the joints as well as fracture of the bones and ripping off of the skin; (3) where the fingers are extensively split longitudinally (Fig. 6); (4) another condition, which surgeons in large manufacturing centres are certain to meet with, requires grave consideration—i.e., where a hand is flayed, owing to its having been caught between rollers which hold, but do not crush: here, as the patient draws back, the skin is stripped off, like a glove, up to the wrist. If, in addition, bones are crushed, the palmar thecæ opened, amputation, leaving part of one finger, if the thumb is intact, or through the wrist-joint, should be performed at once; and Billroth (*Lect. on Surg., Pathology, and Therapeutics: Syd. Soc. Trans.*, vol. i. p. 207) advises this step where the skin is completely stripped off without other injury, fingers entirely deprived of their skin almost invariably becoming gangrenous, and the result being, "under the most favourable circumstances, nothing more than an unwieldy cicatrised stump."

The following case (Dr. Gregory, of St. Louis, U.S., *Trans. Amer. Surg. Assoc.*, vol. ii. p. 232) is a good instance of the truth of the above:—

"The hand of a little boy was caught in the rolling machine of a bakery, and the skin divided at the wrist, just as cleanly as if it had been done by intention, and an entire glove of the skin taken off. When I saw it, it was held on by the tips of the fingers only. There was no injury other than that described. I felt satisfied that amputation was proper; but the patient insisted that he was willing to take the risk if amputation was not performed, and I replaced the flap, and stitched it in several places, believing that it would slough. It did slough, and he lost his fingers up to the knuckles, and the only part that was saved was a small portion of the thumb, and the metacarpal portion of the hand. This, of course, was a cicatricial surface, which I covered with grafts, and it finally healed. The boy can hold a pen in a little groove by the side of the thumb, and it is probable that the remnant of the hand will finally become useful."

The explanation of the certainty with which the stripped-off skin dies in these cases, and the uselessness of the most careful stitching, lies in the fact that not only have the vessels passing from the deep parts to the skin been torn through, but the skin itself has been submitted to an enormous strain and dragging.

In such cases where it is clear the glove-like skin must go, but the deeper parts are uninjured, an attempt should be made by skin-grafting, after Thiersch's method (p. 233), or by pedunculated flaps (p. 20), to provide a covering, and prevent the sloughing of the deeper parts.

v. **Skin-grafting** is especially to be made use of where, after an injury to the hand, it may be possible to save one or two fingers only, or, particularly, the thumb and index finger, by taking skin, if possible, or a pedunculated flap, from the damaged hand, the opposite arm, or the belly. In slighter cases large grafts taken by Thiersch's method (*q.v.*) from the arm will be employed. Dr. Schreiber (*Munch. Med. Woch.*, Aug. 19, 1892) advises skin-grafting in smaller injuries. Thus, if the skin be torn away from the dorsum of a finger, over-extension will follow when the wound is healed unless it is grafted. On the other hand, if it be the pulp that is torn away, successful grafting will give a rounded, sensitive, fleshy end, instead of a thin, sensitive, pointed one. The surgeon must, of course, prepare his patient for disappointment. The grafts may die, and the injured part be reduced to a claw, active movement largely disappearing. Skin-grafting may also be made use of later on if one or more fingers become contracted, and division of the cicatrix leave a gaping wound. The above remarks refer to skin-grafting for small areas on the fingers, and the back of the hand only. The case of the palm and the employment of pedunculated flaps is referred to later (p. 20).

In some cases the method of *désossement* of French surgeons will be useful in supplementing or replacing skin-grafting. Supposing that in a case of severe laceration, in which it is determined to try and save the hand, one finger requires amputation; by turning out the bone, removing the nail and tendons, some of the soft parts thus left may be utilised in filling up any large gap below. The incision, *en raquette*, is made along the dorsum or palmar aspect according as it is desired that the soft parts of the finger should fall into place along the back or front of the hand.

Mr. C. B. Keetley, whose ingenuity is well known, made use of the soft parts in a different way (*Lan.*, March 4, 1905).

A young woman had all the fingers of the right hand crushed and torn, and on the palmar surface burnt, by the hot roller of a machine-mangle. "Nearly every interphalangeal joint was open on the palmar aspect. All the flexor tendons of the middle and ring fingers were destroyed. But their dorsal tendons were intact. I therefore amputated the ring finger, preserving all its dorsal soft structures. These being then brought round and fixed to the previously refreshed palmar surface of the phalanges and joints of the middle finger, the extensors of the ring assumed the duties of flexors of the middle finger. The results, both as regards appearance and function, were surprisingly good."

vi. **Injury to Joints.**—Where the tendons are uninjured, or can be sutured, where there is no extensive comminution of bone or great injury to the skin, the finger will, of course, be saved. If expectant treatment is adopted, even if the parts heal quickly, the surgeon will be fortunate if he manages to preserve for his patient half the natural range of movement of the joints affected. And, to do this, splints—of perforated zinc, not of wood alone—will have to be frequently changed, the part being put up for a short time flexed, then extended, massage assiduously employed, &c.

I am of opinion that excision of a joint which has been freely opened will restore better movement if the patient is brave and persevering. It should certainly be tried—and removal of the bones carried out sufficiently widely to prevent any risk of ankylosis—in the case of the joints of the thumb (p. 15).

vii. **Injury to Tendons.**—This is fully considered at p. 40.

viii. To sum up the chief points:—Primary amputations, especially what may be called formal operations, are only to be made use of under the very rarest circumstances: any surgeon who makes use of them will almost always find that he has overstepped what was absolutely needful. The part should be thoroughly cleansed (with the aid of an anæsthetic), by means of turpentine and soap, with a sterilised nail-brush, and lotio hydr. perch. (1 in 2000), lysol (2 p.c.); these solutions being used continuously hot in an arm-bath. A word of warning may not be out of place here. In his desire to obtain asepsis the surgeon should remember possible effects of overstrong, irritating chemicals, such as formalin, carbolic acid, &c. The vitality of the soft parts is much lowered, and, in the case of the fingers, they are, on three aspects, thin and easily compressed against closely adjacent bones. The hopelessly damaged soft parts should be trimmed and drainage

FIG. 13.



provided. It is only by great care here that the surgeon is justified in submitting his patient, during the attempt to save a mangled part, to the risks of infection, gangrene, tetanus, &c. If there is any doubt as to the completeness of the cleansing, the part should be kept in an arm-bath with a weak aseptic lotion, constantly renewed. But it is always advisable to get the wound sweet and safe under a boracic acid fomentation and at rest on a splint as soon as possible. If any part must be amputated, a flap of skin or tendon that may be useful is to be transferred to the parts that are being saved. So, too, later on, if a surface is left, which by cicatrising slowly will lead to distortion, or if tendons exposed have fibrillated and died, an attempt must be made to cover the one by flaps taken close by or from a distance, and replace the other by distance-sutures (p. 48). Secondary operations will also include removal of any painful stumps, especially those which interfere with the approximation of the thumb to another finger.

Fig. 13 is an excellent instance of what may be effected by conservative surgery here. It represents the remains of a hand, consisting of the thumb, stump of the index and of the li

finger, and also shows of how much flexion the shortened index is still capable.*

Value of Pedunculated Flaps in Injuries of the Hand.—This method, which we owe to Dr. Fenger, is described in a lucid article by

FIG. 14.



Dr. Schroeder of Chicago (*Amer. Journ. Med. Sci.*, Oct., 1900, p. 435). It is pointed out that Thiersch's method does not give either the elasticity or resistance which are especially needed in the palm: the

FIG. 15.



resulting scar is also prone to break down. It may, however, be usefully employed on the dorsum.

Dr. Schroeder's patient was aged 30, the right hand, contracted into a fist, had been left untreated since a burn in infancy. Its functions were almost entirely lost (Fig. 14). The hand and right hip were most carefully prepared for two days. The operations were six in number.

* The figure is taken from a paper on Railway Injuries, by Dr. Thomson, of Kentucky: *Trans. Amer. Surg. Assoc.*, vol. ii. p. 190.

First Operation.—The cicatricial tissue was dissected off the palm, fingers, and thumb. This left a wound extending from the carpo-metacarpal joints to the distal phalanges (Fig. 15). The deformity of the thumb was corrected, but the new position was maintained with difficulty. The first finger was still flexed by the shortened anterior ligament of the first interphalangeal joint, which was ruptured in extending the finger. The hand was now placed upon the hip and incisions made in the skin as guides. The upper flap was made wide enough to cover the denuded space above the first row of digital furrows, having an anterior and posterior pedicle, the distal end of the thumb passing out through the posterior pedicle (Fig. 16). The anterior flap passed over to the crest of the ilium. The hand was now placed under this flap, the fingers separated, and incisions made opposite the middle of the distal phalanx of each as guides. The hand was again removed and the pockets made, one for each finger, leaving attachments between the fingers for nourishment and better immobilisation of the fingers. The hand was now

FIG. 16.



Hand in place over the hip.

placed in position and the upper and lower flaps united, as well as the lower border of the lower flap to the fingers, and the upper border of the upper flap to the edge of the skin of the wrist. There are several important precautions to be taken in this step, namely:—(1) Not more than a quarter of an inch of subcutaneous tissue must be taken, because a thicker flap is clumsy and more difficult to unite to the skin of the hand. However, if more is taken it will be absorbed in time. Some subcutaneous tissue must be attached, or the vitality of the flap is endangered. (2) There must be no tension on the pedicles. (3) The edges of the skin of the hand must be undermined for at least one quarter of an inch, so as to allow of easy approximation.

Sterile gauze was placed at the back of the hand, and gauze drains behind the fingers. A large dressing was placed over the hand and retained by adhesive straps. A plaster case was next applied, extending from the shoulder to the gluteo-femoral fold. At the end of three days a trap-door was (Fig. 17) cut in the case and the dressings changed. Boric acid solution was the strongest antiseptic used in these dressings. The wound was dressed every third day.

Second Operation.—This, performed on the eighth day, consisted in dividing the inner

pedicle to where the thumb protruded. Part of this pedicle was united to its former place. The flap was united to the thumb (Fig. 18). A new case was applied because of the broken condition of the old one. Dressing as before.

Third Operation.—On the sixteenth day the remainder of the posterior flap was divided

FIG. 17.



and the flap stitched to the radial side of hand and index finger. The flap was now nourished from the anterior pedicle and interdigital septa and the new adhesions formed.

FIG. 18.



Hand still in place. Thumb liberated.

Fourth Operation.—On the twenty-second day the inner pedicle was divided and stitched to the ulnar side of the palm and little finger. The interdigital septa were

divided, and the hand thus liberated. At this time the granulating wound on the hip was curetted, partly closed by undermining the skin around it, and then grafted.

Fifth Operation.—On the twenty-seventh day the bridges of flap between the index and second and between the little and ring fingers were divided and sutured to their respective edges of the finger.

Sixth Operation.—On the thirty-second day the bridge between the second and ring finger was divided, and the parts sutured as before.

Whenever an edge of flap was united to the edge of normal skin, it was necessary to dissect back the skin, freshen the edges and bevel those of the flap below, so that good coaptation would be possible, and primary union assured. Dr. Schroeder with great candour states that it was not possible in any of his cases to avoid infection absolutely, but by frequent dressings and proper drainage this did not interfere with a good result. In this case the joint opened in the index finger became ankylosed. The usefulness of the hand

FIG. 19.



was very much improved, and the patient, three months after the operation (Fig. 19), was able to partially flex and extend the fingers. Three other cases are given. In one, also resulting from a burn, a useful hand resulted. The remaining two were due to injury. In one, where the hand had been caught between rollers, the greater part of the skin on the palm and dorsum was torn away and the flexor tendons freely exposed in the palm. A single flap was taken from the hip and its free edge united to the radial side of the thumb and upper and lower edge of the palm. A most complete result followed. In the last case, after an attempt to save a very badly crushed hand had failed, the fingers and most of the skin on the palm and dorsum died: the stump was grafted from the hip. After several weeks the pedicle was lengthened, cut low down, and the flap turned up on the dorsum and sutured. The result was good, giving the patient a stump to press the thumb against.

RE-UNION OF SEVERED DIGITS.

The question will sometimes arise as to the advisability of attempting to re-unite portions of severed fingers and thumbs.

Many such successful cases have occurred, and the surgeon may well

make the attempt, when the parts are cleanly severed, through a phalanx, especially the distal one; and when the patient is young and healthy, as is often the case in country-practice: when the cut has passed through a joint, not through a phalanx, the outlook is far less promising.

The following are instances of the parts severed:

The first, second, and third fingers cut off above a diagonal line beginning in the middle phalanx of the index finger and ending in the last phalanx of the third finger near the root of the nail. The parts had been lying in the snow for some time and were kept for two or three hours before being applied. In other cases the part has been severed longitudinally, containing in it a portion of bone split off. The time between the injury and the treatment has varied from twenty minutes to three or four hours, and the severed part has been picked out of sawdust, brought up in dirty paper, whilst in a third the patient was sent back to find it in the field in which he had been reaping.

When there is the least shred of soft parts left holding on the severed bit, even a bad compound fracture of the finger with severe laceration of the soft parts may be saved.

The age and condition of the patient, the time which has elapsed since the injury, the part affected—*i.e.*, whether the index finger or the thumb—must all be considered. And in any case the patient should be warned that, though the attempt may succeed, the parts unite, and sensation be restored, the result may be a stiff and therefore comparatively useless member.

If it be decided to make the attempt, the part should be carefully cleansed with soap and water, turpentine, hot mercury perchloride solution (1 in 2000), united exactly with a few points of fine wire or salmon-gut and horsehair sutures, enveloped in aseptic wool, and kept *in situ* with carefully adjusted splints of perforated zinc. The dressings should not be disturbed for at least three days, if possible.*

SUPERNUMERARY DIGITS.

This congenital deformity is sufficiently common and important to require a brief notice. The chief point of importance, from a practical point of view, is the mode of junction of the supernumerary digit. This, consisting of two or three phalanges, may be joined by mere fibrous tissue; in other cases there may be a complete articulation between it and the side of an adjacent metacarpal bone, or the carpus, a metacarpal bone being usually present, in addition to the phalanges, in the latter case. Lastly, the allied condition of a *supernumerary phalanx* may be present in cases where the terminal phalanx of a thumb or finger is bifid.

Treatment.—This consists of amputation, as early as possible, with strict aseptic precautions, so as to secure primary union and a perfect scar in a part where a deformity is so noticeable, and also to prevent the risks of infection when a joint is opened. In each case the finger

* Numerous cases of this kind will be found in the *Lancet* for 1861, vol. ii., and later (*Annals of Surgery*, March, 1887, p. 263), fifteen such cases, with good results, have been tabulated by Dr. Pilcher.

is removed by an elliptical incision, the flaps being cut so as to meet exactly; where the union is fibrous, this is all that is required. But where an articular surface is present, this must be exposed after disarticulation of the finger, and sufficient of the joint chiselled or cut away with strong scissors so as to leave the surface of the bone plane and uniform; otherwise growth will continue at this spot up to adult age, and a very unsightly deformity may be produced. When the articulation is with the carpus, additional care is required in carrying out the above steps.

In the case of a bifid phalanx the treatment involves more trouble on the part of both surgeon and patient or the friends, if the result is to be satisfactory. That portion of the phalanx which is the largest, which diverges least from the straight line, and which carries the best-developed nail (if these three points coincide) is to be preserved, and the other one removed. In carrying out this step, if the phalanx be not completely bifid, it should be split down through its base with a chisel, bone-forceps or strong scissors, and the part to be removed taken away. Any ligaments—*e.g.*, the lateral on the opposite side—or structures which will prevent the part left from being brought into the straight line should be divided. As soon as the wound is healed, careful movements of the joints and bringing the phalanx into the straight line must be practised every few days, and a metal splint worn with a collar round the wrist, with a lateral prolongation coming up along the affected finger or thumb on the side away from that to which the phalanx projects, this prolongation admitting of being bent outwards to any needful extent; by this means the phalanx which is at fault can be drawn straight. But persevering daily treatment for four or six months will be required.

WEBBED FINGERS (Figs. 20, 21 and 22).

These should always be remedied in early childhood; if left untouched, the fingers may be useful, but the annoyance of the deformity will be serious. The surgeon should not yield to pressure put on him to operate in early infancy. Simple division of the web—a trifling operation—is out of the question owing to the inevitable recurrence of the deformity. On the other hand, especially if extensive dissections are made in raising flaps, the loss of blood will be considerable, and not without risk both as to the vitality of the flaps and of the infant itself. No operation should be undertaken before the child is at least three years old; in cases where the union is very close I have preferred to wait till the age of four. Where several fingers are united, quite a month should elapse between the operations on the first and second pairs.

As is stated below, the variety of the uniting medium will, to a certain extent, affect the operation chosen; thus, whether the web is lax and free (Fig. 20), or close and thick (Fig. 23), or whether two fingers are fused together by bony union.

1. The simpler methods—*viz.*, wearing a large metal ring through a hole made where the cleft should begin, or passing large silver wire or fine drainage-tubing through such a hole, the ends of the tubing being

attached to a wristlet or bracelet, and the wire twisted in a loop round an adjacent finger—one of these may be tried first, and tubing has the advantage of allowing the hand to move more freely.* When the perforation is soundly healed—i.e., in about four weeks—the web should be slit up, each half split, dissected up for a little way, and the edges of the two flaps thus formed united with a few points of sterilised horse-hair. A sharp-pointed probe will be needed to keep the protruding fat in place. The fingers should be kept apart throughout the healing.

This method has the disadvantage of being tedious, and the formation of epidermis round the foreign body is liable to be incomplete.

2. If the above fail, one of the following plastic operations should be made use of:

AGNEW'S OR NORTON'S† (Figs. 20 and 21).—This is intended for cases where the web is ample. Small triangular flaps are raised in

FIG. 20.



Agnew's operation for webbed fingers. The flap is dorsal, large, and single.
(Keen and White: *American Text-book of Surgery*.)

Norton's operation, on the dorsal and palmar aspects; the webs are then cut through and the flaps very carefully stitched together without tension. The object is to ensure rapid union in the commencement of the cleft, and thus no re-development of the web. A better plan, Agnew's, employs a single larger flap (Fig. 20) raised from the dorsum. The flap should be thick enough to avoid risk of sloughing, and somewhat narrow to prevent bulging. To prevent tension it should be sufficiently long, its base being at the level of the metacarpo-phalangeal joints, and its apex, which should be rounded, almost reaching to the base of the second phalanges. The apex is sutured to the palmar edge of the cleft, and its sides to the skin at the edge of the wound. Any tissue between the knuckles that prevents their coming together should be cut away. The remaining web is then split, and treated as above described. The line of the natural web should be carefully observed.

* This old-fashioned step will still be found useful in cases where the union is close.

† *British Medical Journal*, 1881, ii. 931. On the Continent this operation goes by the name of Morel-Lavallée. Zeller, also, to avoid trenching on the palm, advocated the use of a single dorsal flap.

DIDOT'S (Fig. 22).—This operation was introduced for cases in which the web is very narrow. Two narrow longitudinal flaps are dissected up as thick as possible from the palmar and dorsal aspects of the affected fingers by two incisions, one along the middle line of the dorsum of one finger and another along the middle line of the palmar surface of the other, from a point opposite to the extremity of the web to the knuckle. By transverse incisions at each end of the vertical ones (Fig. 22) two flaps are marked out. These are most carefully dissected up (see below), and each flap is then folded round to cover in the raw surface of the finger to which it is attached, and secured with

FIG. 21.



Norton's operation for webbed fingers.
The flaps are small and double.

FIG. 22.



Didot's operation for webbed fingers.
(Reeves.)

a few points of interrupted sutures of very fine sterilised salmon-gut and horsehair.

Didot's, like many French operations, is most ingenious, and, on paper, it looks an excellent one. But, in practice, the following objections will present themselves: (1) It is a severe operation, especially in little children. (2) It is not easy to raise satisfactory flaps in parts so small and with skin so little developed. Thus, if the flaps are thick enough, it is easy to injure the extensor tendons or digital nerves or vessels, and thus to run the risk of necrosis of the terminal phalanx; on the other hand, if the flaps are too thin they slough, and infection readily occurs. (3) The flaps are nearly always insufficient to cover the denuded surfaces unless they are submitted to such tension as may lead to sloughing. Thus in part the wounds must heal by granulation, which may lead to harmful scars, or by the aid of skin-grafting, which is liable to be rendered futile by the restlessness of the patient. (4) Considerable difficulty will be met with in fitting neatly the quadrangular edges of the flaps at the roots of the fingers so as to satisfactorily re-establish the web.

For the above reasons I prefer the method of operating by a triangular flap (Figs. 20 and 21) wherever the web is loose enough to render this feasible.

Mr. Bidwell in one case (*Lancet*, June 29, 1895) combined the methods of a flap from the web with one from the dorsum of one finger, and skin-grafting.

In those rare cases where the union is bony, the choice lies between (a) leaving things as they are, or (b) removing the bone of one of the united fingers after exposing this adequately by two rectangular flaps, dorsal and palmar. If any other step is taken and the fingers divided, there is a risk that both may need to be amputated.

After all operations on webbed fingers, especially the one introduced by Didot, there is more or less tendency for the fingers to become stiffly flexed or extended, according as any excess of scar has formed on the palmar or dorsal surface. Thus it is very common for the finger which has the dorsal flap, and in which the cicatrix lies along the palmar surface, to become flexed. This tendency must be met by persevering use of a splint, one similar to that mentioned at p. 29 being applied to the dorsal or palmar surface of the finger as required. At first it must be worn day and night, and then removed for varying periods in the day to admit of active and passive movements being assiduously practised. It will require to be worn at night for many months. In a few cases of this deformity a pedunculated flap taken from the dorsum will provide the most extensive and mobile skin in the position of the web.

CONTRACTED PALMAR FASCIA AND OTHER CONTRACTIONS OF THE FINGERS (Figs. 23, 24 and 25).

It is well known that occasionally contraction of the palmar fascia takes place, especially that part of it going to the inner two fingers, being due partly to constitutional, partly to local causes. Commencing about the transverse palmar creases, it steadily cripples the hand by drawing down the fingers, causing flexion, first at the metacarpophalangeal, and later at the inter-phalangeal joints (Fig. 23).

Operation.—This may be either subcutaneous, by multiple punctures; or open, this being effected either by multiple transverse cuts through an open longitudinal incision, or by excision of the contracted fascia. I prefer the first two, for the reasons given below.

The Subcutaneous.—The best is Mr. Adams' method,* by multiple punctures from the surface downwards. The skin must first, for a day or two, be carefully prepared and cleansed. Where general anæsthesia is contra-indicated, encaine may be substituted. Professor Keen has proved the value of this (*American Medicine*, October 31, 1903, p. 704). The patient, aged 62, suffered from chronic bronchitis and had a distinct murmur with the first cardiac sound. The tissues over the median and ulnar nerves at the wrist having been injected, these two nerves were exposed, and twelve to fifteen drops of a one per cent. solution of cocaine were injected into each. Two contracted cords of

* *Finger Contraction and Depressed Cicatrices* (Churchill, 1892).

palmar fascia were then dissected out, and their extension on to the second phalanx of the two fingers affected thoroughly severed. The operation lasted nearly fifty minutes. At no time did the patient suffer the slightest pain. The result was satisfactory. The fingers could be fully extended at the knuckles, but were still slightly contracted at the second joints. Finding some spot where adhesion of the skin to the fascia has not yet taken place, the surgeon, avoiding the site of the vessels, passes a delicate fascia-knife, or a fine, small tenotomy knife, between the skin and fascia, and divides the band from above downwards, taking care not to dip the point too freely. If too much straightening is attempted at once, the punctures will gape widely and readily tear, especially where the skin and fascia are adherent. In cases of contraction of two fingers, multiple punctures—*e.g.*, five to nine—may be required. It is very easy, by operating on the palmar cords, to rectify the contraction at the metacarpo-phalangeal joint. The straightening of the contraction often met with between the first and second phalanges is much more difficult. The digital prolongations of the fascia may be divided by punctures in the web between the fingers, extreme care being required to avoid the digital vessels and nerves by not dipping the point, and keeping to the middle line. But when the surgeon finds some difficulty in correcting this contraction thoroughly, I am of opinion that he will act most wisely by correcting the remaining contraction gradually by the use of Mr. Adams' finger-splint with rack-and-pinion movements opposite the metacarpo-phalangeal and inter-phalangeal joints.* Those of aluminium or xylonite are recommended by Mr. Keetley (*Orthopædic Surgery*, p. 237). The metal should be thick enough not to bend like lead. The splints should accurately fit the palm, and the length and breadth of each finger. They are secured by broad strips of soft leather. At intervals during the day whatever splint is employed should be removed, and the hands well soaked in hot water, scrubbed in this with a nail-brush, and the patient assiduously practise placing the affected finger-tips on a table, and then, standing up, making pressure on the dorsal surface of the fingers with those of the other hand. In any occupation which entails much grasping, gloves padded on the palmar surface should be worn (Keetley). The skin should be first most carefully cleansed, and an aseptic dressing applied for three or four days, when the punctures will be practically healed. The splint should be worn day and night at first, carefully padded at all pressure points. Some weeks will be required to correct the phalangeal contraction, and in advanced cases relapses can only be prevented by the persevering use of the splint. If the surgeon attempts to straighten completely an advanced case of phalangeal as well as metacarpo-phalangeal contraction, he runs the risk (1) (by dividing a digital nerve) of causing slight gangrene of the finger-tips or most intolerable pain, and (2) of damaging the tendons, for sometimes these bands are closely related to the theca in the fingers. The following threefold association of the palmar fascia with adjacent structures is now, by the disease, rendered more intimate than ever;

* *Loc. supra cit.*, Fig. 10. Other splints will be found figured by Mr. Adams, *Lancet*, 1891, vol. ii. p. 166. If the skin has been much strained or interfered with, the straightening should be deferred for a few days.

viz., (1) a central slip to the theca; (2) slips to the skin of the web; and (3) to the superficial transverse ligament.

For fear of relapses the patient should, regularly and methodically, practise active and passive movements of the joints, wear the splint at night for a considerable time, and if any persistent or recurrent bands threaten to be troublesome, treat these by blistering and rubbing in oleate of mercury, vaseline, &c. In any employment involving much local pressure and irritation gloves must be worn; and if the patient

FIG. 23.



be the subject of the gout of the present day, if he take too much alcohol, &c., he must be advised accordingly.

Figs. 23 and 24* represent a right hand crippled with contraction of the palmar fascia, before and five years after operation. The man was a patient of Dr. J. E. B. Burroughs, of Lee, and was operated on by me in 1883, the contraction of the metacarpo-phalangeal joints being straightened at once after numerous punctures made in the manner above given, while that at the inter-phalangeal joints was remedied chiefly by the persevering use of Mr. Adams' splint, already alluded to. In 1890 the fingers could be completely extended, were perfectly mobile, and free from the slightest tendency to contraction. It will be seen from Fig. 24 that some thickening, puckering, and corrugation of

* The asterisks in Fig. 24 show spots where the fascia-knife might be introduced in contraction of the palmar fascia slip going to the ring-finger. The contracted band or bridle, thus isolated by the punctures, undergoes softening and atrophy.

the palmar skin and fascia still persists, but this had now no power of producing contraction, the patient, one of the relieving officers to the Lewisham Union, being able to write, &c., without any hindrance whatever. But, to show the importance of persevering in the after-treatment mentioned above, when, after another four years, I again saw the patient, in 1894, there was some recurrence of the flexion of the inter-phalangeal joints. The above advice, on which I had insisted, had been entirely neglected. And this is very often the case, owing

FIG. 24.



to patients thinking that the operation, of itself, will accomplish everything, and that no responsibility in the after-treatment rests with them.

Operation by Multiple Transverse Cuts through an Open Longitudinal Incision.—This method was advocated by Goyrand, Kocher, and in this country by Mr. Hardie,* of Manchester, and Mr. Keetley. It has been recommended on the ground that mere subcutaneous division of the contracted palmar fascia cannot be sufficient if the thickened, puckered, hardened skin is left alone, and also that intimate adhesion of the altered skin to the fascia is so general that it is difficult, if not impossible, to get the knife between the two at a sufficient number of spots for adequate straightening by the subcutaneous method. Mr. Keetley, who advocates this operation

* *Medical Chronicle*, vol. i. No. 1, p. 9. A diagram of the different incisions, which may be found useful, according as the band is linear or branching, is given by Mr. Anderson (*loc. supra cit.*), *Lancet*, 1891, vol. ii. p. 59.

because of its "absolute precision" (*Orthopædic Surgery*, p. 239), thus describes the steps. "The limb having been elevated and an Esmarch' bandage applied, the hand and forearm, carefully sterilised, are held down extended and supinated on a sterilised towel on a small table beside the operating table, with the fingers as much extended and separated as possible. It is here that the difficulties begin. A longitudinal incision is made through the skin and into the contracted fascia. If the finger is much contracted, this incision can only be completed by degrees, as the division of the bands gradually permits the unfolding of the fingers. The extent and degree of the contracted fascia are now easily seen, and it should be divided transversely and completely in many places until all resistance is removed, and nothing but nutritive

FIG. 25.



A finger, the subject of Dupuytren's contraction, has been straightened by the open method with a v-shaped incision.

(Tillmanns.)

shortening of the structure around and acting on the finger-joints remains. This should be left to be overcome by after-treatment. Here and there the skin itself may have to be freed by a touch of the knife. The skin incision is closed by silkworm-gut sutures placed close to the edges of the wound. If the above directions are strictly followed, merely a linear cicatrix will remain, such as contrasts favourably with what has been reported as the ultimate state of things after excision of the contracted fascia."

Excision by Dissecting out the Contracted Bands.—(a) By Rectangular Flaps.—

The skin having been, for two days at least, softened and sterilised as much as possible, a longitudinal incision is made over the contracted band from its upper to its lower limit, and then small transverse incisions are made at each end of the longitudinal one so that small rectangular flaps may be dissected up. A twofold difficulty at once presents itself: the skin is usually so adherent in places that the satisfactory making of these flaps is by no means easy, a difficulty much increased by the flexed position of the finger affected. The band of contracted fascia, when exposed, is dissected out, all bleeding arrested, and the flaps united with sterilised horsehair. Another difficulty presents itself here owing to the contraction and adhesion of the skin which has to be united. Where union is impossible, skin-grafting* must be employed: any surface left to granulate means more or less recurrence of the troubles.

(b) A V-shaped Incision (Fig. 25).—The base of the V is opposite

* Skin-grafting has been somewhat lightly recommended in these cases as certain to complete the healing. I would impress these cautions on my readers: (a) any unhealed surface remaining after an open operation for contracted palmar fascia is far from being an ideal one for skin-grafting, like the smooth, level, regular surface of a large ulcer, or that which may remain after the removal of a carcinomatous breast; (b) when the surface to be grafted is of any extent, and the hand one much employed in manual labour, the grafts, being merely epithelial, may not afford sufficiently permanent protection (p. 20). Plastic operations, suggested by some, are out of the question in these patients, both from a local and a more general point of view.

to, a little above and overlapping the root of the affected finger; the apex is situated in a line with the centre of the same finger, in the palm, about on a level with the highest transverse crease. Two diverging incisions join these points, and are carried down through the skin and fascia. If the latter can be divided completely or removed entirely, the finger can be straightened. This leaves a gaping triangular wound in the palm, with its apex upwards. Theoretically, this should be united by careful stitching in the form of a Y. But the contracted state of the skin almost always prevents accurate stitching, and leads to some gaping of the wound, and a raw surface which may require grafting.

For the severest cases Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, part ii. p. 23) recommend a combination of the subcutaneous method and the V-shaped incision. "In very advanced cases, where the fingers are tightly bound down to the palm, removal of the fascia by dissection cannot be performed, because it is impossible, on account of the contraction of the fingers, to get proper access to the palm so as to make the requisite incisions. Under these circumstances the best treatment is to perform tenotomy* in the first instance, and to get the finger as straight as possible by these means.

"As a rule, however, tenotomy will not allow the finger to come quite straight, because the skin itself is contracted, and therefore the result is incomplete. The operation by the V-shaped incision may be very usefully combined with tenotomy so as to compel the straightening of the fingers. The two operations should, however, be done at different times. The result of the tenotomy is to endanger the vitality of the skin at various points; this, however, very rarely sloughs, unless too great pressure be brought to bear upon it. Hence a sufficient time must be allowed to elapse between the tenotomy and the open operation to allow these damaged portions of skin to recover, and during this time the fingers should be kept somewhat extended on a splint; three weeks' interval is usually enough."

Before performing any operation for excision of the contracted fascia the surgeon should remember Mr. Keetley's warning (*loc. supra cit.*, p. 240): "Whether owing to defect in the operation itself, or in the mode of carrying it out, I cannot say, but there is strong evidence to show that it is, in a serious proportion of cases, followed by a considerable danger of cicatricial contraction. Consult on this point Macready's paper in the *British Medical Journal*, 1890, vol. i. p. 411. One patient at least complained of an unpleasant sensation when the scars were touched. The total removal of the contracted fascia necessarily takes away its capacity for protecting the underlying nerves. If contracted palmar fascia were a new growth, its excision would, of course, be plainly indicated; but it is, at the worst, an effect of a chronic inflammatory process, and further, there is the risk that in complete excision another form of contraction, namely, cicatricial, may be substituted for the original one."

For the reasons given below I advise the adoption of the method by

* Division of the fascia is meant.

multiple incisions in all the less severe cases. Nowadays, with all the advantages of modern surgery there is no excuse for the patient's remaining for treatment early. In these cases, and these ought to be exceptional where the infiltration is more widespread and dense a longitudinal incision and multiple transverse sections of the band should be employed. In answer to the objection that the method recommended is liable to be followed by relapses, I admit it, but reply that this may be followed by other and somewhat more radical steps. An I maintain that where relapses do follow they are due to the patient either not being duly warned or to their neglecting the warning; thus this method may for completeness and safety require repetition, and that, in any case, it demands, imperatively, that much of the responsibility for success lies with them in the after-treatment. Thus it calls for patience, assiduous attention to the employment of splints and the needful manipulations for many months, and the giving up very largely of alcohol, especially whiskey. Where these essentials are attended to, relapses, in my experience, will not occur.

Those who prefer the more recently advocated method must remember the following points, viz., the age and vitality of many of these patients; the need of thorough sterilisation of the skin—not an easy matter when the contraction of the fingers renders access to all the hollows and inequalities difficult; the oozing and possible need of a drain; the fact that the puckered state of the skin always make accurate stitching difficult, leading to a raw surface and the need of grafting, of the objections to which I have already spoken, a need which is increased by the tendency of the sutures which it has been possible to insert to cut their way out owing to the necessary tension in places and the poorly vitalised condition of the skin. Lastly, there is the swelling of the hand which may occur, especially in gout patients, and which interferes greatly with the use of splints.

CONGENITAL AND OTHER CONTRACTIONS OF THE FINGERS.

In addition to Dupuytren's contraction, there is a **congenital** form, occurring chiefly in girls, in which one finger, usually the little one, is flexed at the first inter-phalangeal joint. The condition may be bilateral. The mischief appears to lie in a contraction of the fascia of the finger, not of the palm, and in the centre, not at the sides. I have seen several cases, and in none was there any real interference with the usefulness of the hand, advice being sought for the sake of the deformity. Palliative treatment can only be of avail in early life, when the small size of the parts renders it difficult to carry out. If operation be undertaken, the open method with multiple transverse incisions can be easily made use of as the skin is not affected, and the band is median, and thus the digital vessels and nerves are not endangered. If the above be insufficient, the lateral ligament must be divided, and tendon-lengthening may be needful: in the most confirmed cases where ankylosis is present, the question of resection, osteotomy or amputation will arise.

Severe Contractions due to Injury.—Here such steps as tendon-lengthening (p. 46), combined with plastic operations on the lines of that described at p. 20, may occasionally, be resorted to with benefit.

Snap or Trigger Finger.—Here full flexion, more rarely extension of one finger, is prevented and can only be attained by the patient resorting to the other hand, the finger being now suddenly flexed or extended with a snap like the closing of a blade of a pocket knife. The pathology is uncertain. In some a synovial fringe has been found thickened

in others a bursa (Keetley), or the joint surfaces have been found altered by a condition such as rheumatoid arthritis. *Treatment*: Exploration and removal, if possible, of any cause which may be found.

NEEDLES IN THE HAND.

Those of my readers who are aware of the difficulties which may accompany exploration here, and the unsatisfactory results which sometimes follow on this step, will be too familiar with the need of having two skiagrams, one taken laterally and one antero-posteriorly, for me to emphasise this point. While on this subject I may add two hints, one is that needle fragments may be sometimes multiple here as in the foot, the other, that skiagraphy is especially valuable in doubtful cases, *e.g.*, where a patient, evidently neurotic, complains of a hand being numb and useless, one needle-fragment having been successfully removed.

With regard to the operation itself, I would advise the use of an Esmarch's bandage at the time, and hot boracic acid fomentations for thirty-six or forty-eight hours after the operation.

Where the needle fragment lies very deeply in the palm, especially if a good deal of cicatricial tissue be present from previous operations, a step which I took in October, 1903, of removing the needle from the dorsum by partial excision of a metacarpal bone will be found useful.

A middle-aged woman had been operated on before three times for the removal of a needle from the palm, and it was clear from the scars and contracted state of some of the fingers that an aseptic result had not always been secured. Mr. Shenton demonstrated the presence of a needle-fragment lying deeply on the palmar aspect of the fifth metacarpal bone, a little above its base. Under my supervision, my dresser, Mr. Stevenson, removed the centre of the metacarpal, thus securing access through normal tissues. A rusty black needle-fragment was at once seen embedded in the interossei. The wound, dressed at first with fomentations and kept well elevated, healed quickly, and the patient was again able to use her needle.

PALMAR HÆMORRHAGE.

There are three arterial arches especially concerned in keeping up the arterial supply here—viz., (α) superficial palmar; (β) deep palmar arch; (γ) the carpal arteries around the wrist. These are supplied with blood, not only from the radial and ulnar, but also from the interosseous arteries. Finally, if the *comes nervi mediani* is enlarged, it will join the superficial palmar arch, or one of the digital arteries.

Treatment.—This will vary accordingly as the case is seen early, or later.

A. EARLY CASES.—The surgeon arrests any bleeding* by pressure on the bleeding point while he has the limb raised, and arranges for compressing the brachial, or the radial and ulnar. This securely effected, he thoroughly cleanses the wound and adjacent parts, dries them carefully, and, if the wound gapes at all, endeavours to secure the cut vessel itself. If this fail, or if the wound be a mere puncture, he at once carefully applies compression. And it may be said at once that, if this be wisely and efficiently done, no

* The wound sometimes does not bleed when examined. If there is a history of much bleeding, bleeding *per saltum*, if the depth, &c., of the wound make it probable that an artery is wounded, pressure should be applied. A little later, and the hæmorrhage may break out on the least exertion; this is very likely to occur at night.

further hæmorrhage will take place ; if incompletely or carelessly applied, the patient's limb and life may both be endangered (*vide infra*).

The brachial having been commanded and the wound cleansed, a compress—consisting of sterilised pads, gauze, or lint sufficiently soaked in lysol (2 p.c.), or, failing this, lint soaked in carbolic oil (1 in 20), or tr. benz. co., the pieces of iodoform gauze or lint increasing in size from a threepenny-bit to half-a-crown—is got ready, together with strapping, gauze bandages, and two bits of pencil or bougie. The fingers are now carefully strapped and bandaged, and the compress is then secured in position by careful bandaging. If the above precaution be omitted, so much and so painful œdema of the fingers will take place, as to inevitably lead to early removal of the compress and recurrence of the hæmorrhage. The compress being in position, two bits of pencil wrapped up in gauze are placed over the radial and ulnar arteries, and the bandage carried up to mid-arm. The Esmarch's bandage having been removed from the brachial, a splint is then applied, and the patient, if restless, kept at first under the influence of morphia, the limb being kept well raised. The compress should not be disturbed for three or four days at least.

B. LATER CASES.—If pressure has been tried, but inefficiently because inadequately at first, together with imperfect cleansing of the wound, inflammation will probably have supervened, and the hand will very likely be red, brawny, painful, suppurating. If hæmorrhage still continue after the parts have been relieved by carefully made incisions* it will be wiser to tie the brachial artery at once in the middle of the arm (p. 148) than to tie the radial and ulnar in the lower third of the forearm (pp. 85, 88), and for these reasons :

i. While the anastomoses round the elbow are so free and so reliable as to prevent any risk of gangrene after a ligature of the main vessel, ligature of the radial and ulnar is rendered uncertain owing to—

(a) The anastomoses between the two palmar arches ; (β) The anastomoses between these and the carpal arteries ; (γ) The blood brought down by the interosseous arteries and the comes nervi mediani, which will not be stopped by ligature of the radial and ulnar ; (δ) The fact that, if inflammation has set in, enlargement of the arteries will have taken place.

ii. Ligature of the brachial, by cutting off so much blood, will also help to cut short the inflammation.

iii. Ligature of the brachial will be performed through healthy and uninflamed parts.

An interesting instance of what pressure will effect even if deferred till the eleventh hour is seen in the following case :

A patient, nearly three weeks after the wound, having had attacks of recurrent hæmorrhage, entered St. Bartholomew's Hospital, and Mr. Skey tied the radial and ulnar. When the ligature separated from the ulnar, hæmorrhage took place, and the artery was again tied in the middle third. Hæmorrhage recurring, the brachial was tied in the lower third. This last operation failed to arrest the hæmorrhage, and the third part of the axillary was tied. About ten days later profuse hæmorrhage from the axillary wound left the patient almost pulseless. The patient's condition not admitting of amputation at the shoulder, the limb was firmly bandaged from the hand to the shoulder. No further bleeding took place, and the man made a good recovery, with a useful arm (*Lancet*, 1855).

In the *Lancet*, 1859, vol. i. p. 506, is recorded the following good instance of the results of pressure inefficiently applied :

The compress, which had been applied to the palmar wound (the man having been made an out-patient), was removed every day, and followed by hæmorrhage. Severe bleeding occurred on the fifth day, ligature of the radial was performed on the seventh, and on the ninth ligature of the brachial lay down. On the eleventh, owing to recurrence of hæmorrhage, the arm was amputated just below the ligature. Chronic pyæmia followed,

* Incisions for supuration in the hand should be made opposite to the centres of the phalanges, opposite to the heads of the metacarpal bones, above the superficial palmar arch by Mr. Hilton's method, and, if above the wrist, the position of the arteries, which may, perhaps, be superficial, and of the median nerve, lying close to the inner side of the palmaris longus, must be remembered.

from which the patient was slowly recovering at the close of the report. No abnormal distribution of vessels was found in the arm.

COMPOUND PALMAR GANGLION. TUBERCULAR TENO-SYNOVITIS.

Practical Points.—(1) There is the risk of spreading infection if the wound be not kept carefully aseptic. (2) Recurrence is very frequent, from the fact that it is difficult to remove all the "melon-seed" bodies which are often present in great abundance. However few may be left behind, these will suffice for continued effusion of fluid, weakening of the ligaments,* and, perhaps, ultimate disorganisation of the joint. (3) This form of ganglion is very often tuberculous. In these cases disease of the carpus is almost certain to follow.

Treatment.—I strongly advise a radical operation here, owing to the frequency with which this disease is tuberculous—it was proved to be so in three of the four cases in which I have operated—and its consequent dangers from its surroundings. But as, in a few cases, this disease may be of a simpler form, and as the surgeon may not always be able to avail himself of the surroundings, skilled assistance, &c., which are an absolute *sine qua non* for the radical operation, I have described a simpler operation first. I do not recommend it, and anyone employing it must remember that if he fail to cure the disease, he will have rendered subsequent needful steps much more difficult (p. 39).

A. The parts having been rendered sterile, an incision should be made $1\frac{1}{2}$ inches above the anterior annular ligament, avoiding the median nerve, and going down into the ganglion, the deep opening† into which is not to be a mere buttonhole, but must be kept free and dilated, otherwise the complete carrying out of the next step, on which a cure depends, will be found impossible. The edges of a free opening into the ganglion being held open by Spencer Wells's forceps, all the "melon-seed" bodies must be removed, partly by pressure, partly by the use of a curette, which should explore all the cavities into which these ganglia are sometimes divided. Thus care should be taken to examine and treat, if needful, the synovial sac enveloping the flexor profundus as well as that in relation with the superficial flexor. The question of providing a second opening below the anterior annular ligament will now arise. Where the ganglion is a large one, where the "melon-seed" bodies are numerous, where it is desirable to provide thorough drainage, a second opening should be made. This may be safely done by passing a bullet-probe or dressing-forceps from the upper opening under the annular ligament, and cutting down upon it through the palmar fascia, the palmar arch being avoided. This opening having been enlarged with dressing-forceps, the curette is again applied, if needful, and when, either by this means, or by rubbing between the opening a strip of sterile gauze, all the "melon-seed" bodies are detached and removed, the cavity is

* If for any reason the operative treatment of compound ganglion is deferred, some well-adjusted form of support and compression should be worn, otherwise delay will lead to dangerous stretching of the ligaments and weakening of the joint.

† If on cutting into the ganglion it is found thick, velvety and vascular, this operation is certain to fail.

washed out with a sterile saline solution—whatever fluid is used all of it should be withdrawn—and then a drain of sterilised horsehair is passed by means of the probe from below upwards. Strands of this may be withdrawn as needed. The hand may be conveniently put up with the fingers flexed, as on a Carr's splint. All should be healed in three weeks, at which date movements, which may be cautiously begun before, should be actively persevered with.

B. A more radical operation should in my opinion be performed in every case, owing to the frequency with which teno-synovitis here is tuberculous, and the risk of the infection extending to the carpus. It should certainly be performed where the disease recurs, or where there is reason to suspect tuberculous mischief. The ganglion having been opened by the steps given above, but with much freer incisions, its walls will certainly be found to be thick and velvety, perhaps showing vascular fringes over the tendons. In such cases each of the tendons must be separately hooked up and cleaned with curved, blunt-pointed scissors and dissecting forceps, the diseased tissue being removed in as large continuous pieces as possible. To eradicate the whole of the tubercular mischief it will be needful to divide the anterior annular ligament, the position of the median nerve being first carefully noted. The four cases given below, in which I have taken this step, show that no weakening of the hand need be feared. The incision must be boldly made from about $1\frac{1}{2}$ inch above the annular ligament down through this structure to a point just above the level of the superficial palmar arch. Otherwise there is danger that, by insufficient exposure of the parts, persistence of the tuberculous mischief, and, ultimately, disease of the carpus, may ensue. When by the use of a strabismus-hook, dissecting-forceps and blunt pointed scissors each individual tendon has been cleaned as thoroughly as possible, the surgeon examines for the presence of bone disease, flushes out the parts with sterile saline solution, followed by rubbing in of sterilised powdered iodoform made into a paste with lotio hydr. perch. (1 in 1000). During the operation every bleeding point must be arrested by ligature with fine sterilised silk. The use of forci-pressure is less advisable owing to the risk of damage to the tendons. The annular ligament is then united with buried sutures of sterile silk, and dressings applied with uniform pressure, so as to distribute the oozing, which will probably be free, through as wide a surface as possible.

Two more points need reference. First as to the use of an Esmarch's bandage. I do not think this of material importance. I have no always used it. The after-oozing, always free, will be especially so if the bandage be employed. Drainage should be provided by leaving the two or three uppermost sutures of silkworm gut untied for the first three days. Another and more important point is one which, as far as I know, has not received attention, and that is the condition of the sheath of the flexor longus pollicis. There are usually two synovial sheaths beneath the anterior annular ligament, one for the two flexors of the fingers and the median nerve, the other for the long flexor of the thumb. This last extends continuously from above the annular ligament to the base of the ungual phalanx of the thumb. It is not always involved in tuberculous synovitis or compound palmar ganglion. Thus in two of my four cases it had escaped. In two fulness in the

thenar eminence and distinct thickening along the tendon below gave evidence of more extensive tuberculosis. Unwilling to divide the short muscles of the thumb, I laid the sheath open along the two phalanges of the thumb, removed the thickened tuberculous membrane there, and then, by means of a curette and strips of gauze soaked in sterilised iodoform passed by Lord Lister's sinus-forceps from the opening over the thumb below to that above the annular ligament, I curetted and rubbed out, as far as possible, the diseased synovial tissue from that part of the sheath which lies under the muscles of the thenar eminence. As soon as the deep parts of the wounds were healed collodion dressings were employed, and over these, uniform pressure with strapping, applied especially firmly over the thumb. The cure was complete when the patients left the hospital, and remained so (*vide infra*) during the six months which had elapsed since the operation.

After this operation movement of the fingers must be begun as early as possible, to prevent the tendons being matted together after all the interference which is needful at the operation.

I have now employed the radical operation advised above, with division of the anterior annular ligament in four cases. The first, in 1896, was a woman, æt. 53, who earned her living by working at fancy embroidery. Dr. Holland Wright, whose patient the woman was, sent her to me in June, 1904, to show the result. This was perfect. The patient had followed her employment all the time, but there was some evidence of phthisis in the left lung. The second case was a woman æt. 42. Though very numerous melon-seed bodies and much thickening of the synovial membrane was present, this was the only case in which no evidence of tubercle bacilli could be found. When I last saw this patient, 1½ years after the operation, for chronic mastitis, the hand was as good as its fellow. The third and fourth patients were sent me by Dr. Jones, of Alton, almost coincidentally, in 1903. In both the sheath of the flexor longus pollicis was markedly involved. Both were young patients, one a grocer's assistant; the other, a barmaid, had been operated on before by a single incision above the annular ligament. This fact, the disease persisting, greatly increased the difficulty of the operation. In answer to my inquiries, the man wrote to me as follows, about six months after the operation:—"My hand is quite strong, much stronger than when I first felt anything of it. The top joint of the thumb is still stiff, and I can't close the hand quite as well as the other. Otherwise it feels perfectly well." With regard to the fourth case, that of the barmaid who had been operated on before, Dr. Jones wrote about six months after the operation:—"As far as I can see, the result is as perfect as possible. She has regained all movements of fingers; the grip of the hand is a little weaker than on the sound side."

The above proves that, if the same skilled assistance is at hand as I could happily command, there need be no hesitation about division of the annular ligament. With regard to my treatment of the flexor longus pollicis, six months is insufficient to prove anything. At all events, the example is worth following. If the method prove incomplete, I should not hesitate to lay the whole length of the long flexor of the thumb open. A sound hand, at the expense of a less mobile thumb, would certainly be preferable to a hand with tuberculosis,

matted tendons, sinuses, an invaded wrist-joint, and extension to the lungs, &c.

PALMAR ANEURYSM.

The rarity of this disease in arteries so small in size as those of the forearm and hand is well known. Aneurysm when present in the palm is usually the result of injury, or, much more rarely, it is embolic in nature and co-exists with serious disease of the heart.* In a third class of case the aneurysm is an instance of localised subacute endarteritis deformans,† and arises without any known cause. Here other arteries—*e.g.*, the cerebral—are, very probably, also affected. The inner part of the superficial palmar arch is that chiefly affected.

Operation.—If other treatment has failed, if the aneurysm continue to increase, to cause troublesome throbbing, and numbness of the fingers supplied by the ulnar nerve, it is best treated by excision after ligature of the ulnar artery above and below. The skin having been thoroughly cleansed, and an Esmarch's bandage applied above, a longitudinal incision, two to three inches long, is made over the swelling, dividing the skin, palmaris brevis, and palmar fascia. Any tendons and the ulnar nerve are carefully drawn aside. The ulnar artery is then tied with sterilised silk above and below the swelling. The sac is next snipped away with scissors, and, if needful, the deep branch of the ulnar artery is tied also. The palmar fascia should be united with a few buried sutures of fine sterilised silk, and the skin incision closed with sterilised salmon-gut. Movements of the thumb and index finger should be carefully commenced in two or three days, but the other fingers should be kept quiet for the first week. The wound should have healed in ten days.

While the above course is certainly the best, cases which have been recently recorded‡ show that ligature of the ulnar, or of the ulnar and radial, will be sufficient in palmar aneurysm, if, for any reason, the surgeon prefer to adopt this course.

OPERATIONS FOR UNION OF DIVIDED TENDONS. TENORRAPHY. TENOPLASTY.§

As in the case of divided nerves, the union of divided tendons may be **primary** or **secondary**, according as the surgeon is called to the case at once or later.

I always prefer to make the parts thoroughly evascular beforehand with Esmarch's bandages, though this step has been objected to as likely to lead to after-oozing, tension, &c. To meet this, every vessel that can be seen should be carefully secured, the wound thoroughly dried out, and then, after any needful drainage has been provided, and the wound sutured (but not over-closely or tightly), before the Esmarch's bandage is removed the dressings should be applied thickly

* Mr. Holmes, Royal College of Surgeons Lectures, *Lancet*, Oct. 25, 1873; *Syst. of Surg.*, vol. iii. pp. 29, 102, has called attention to this class of case.

† An instructive case, treated successfully by incision of the sac, with interesting remarks on the pathology and treatment of this disease, is recorded by Dr. J. Griffiths of Cambridge, *Brit. Med. Journ.*, vol. ii. 1897, p. 646. See also my case, p. 83.

‡ A. Caddy, of Calcutta, *Lancet*, 1896, vol. ii. p. 603. The aneurysm was traumatic, and the patient 33. The radial and ulnar were tied. W. Robertson, of Glasgow, *Brit. Med. Journ.*, 1897, vol. ii. p. 1637. Here there had been no wound, but the palm had been repeatedly knocked in starting some engine-gear. The patient was 18. The ulnar artery alone was tied.

§ This term, which has been introduced lately, should be reserved for those cases where tendon-suture is found impossible, and tendon-grafting (p. 50) is employed.

and uniformly so as to distribute the discharges through as wide a surface as possible, instead of allowing them to come through at one spot. The controlling bandage must be placed sufficiently high up not to interfere with any pressing down of muscular bellies which may be needed in order to bring a retracted central tendon end into view.

The upper end of the tendon will always give more trouble than is the case with a divided nerve, owing to its greater retraction.

In laying open the sheath to follow up the tendon, most scrupulous care must be taken to use every aseptic precaution, especially in cases where the parts are much disturbed, the sheath extensively opened, &c.; otherwise infection may easily be carried far and deeply, if the retracting end has not already done this. Further, it is in the sheath that the vessels run to which we owe the nutrition and repair of the tendon ends.

For the sake of convenience, operations for the union of divided tendons may be classed under the following heads:

A. Cases where both ends can be found and where they can be easily adjusted.

A longitudinal incision will usually be best, but in some cases—*e.g.*, where the tendons are matted together—a flap may be preferable. Any bruised, sloughy, or scarred tendon tissue is removed as cleanly and charily as possible with a very sharp knife or scissors. Sutures of thoroughly sterilised silk or kangaroo-tail tendon—if sufficiently fine ones are procurable—are preferable to those of chromic gut, which are always liable to give way too soon, especially if suppuration occur. Especially fine fishing gut is considered the best material by Messrs. Watson Cheyne, C.B., and Burghard (*loc. infra cit.*, p. 228). The sutures may be passed and tied (1) *in the ordinary way where the tendon is round, and either of medium or large size.* The silk is passed, on as fine a needle as will carry it, from before backwards through one tendon end, and then from behind forwards through the other, and the ends are knotted on the superficial surface of the tendon. Large tendons may be secured with two lateral or with one central and two lateral sutures, smaller tendons with one median suture only. As the suture is tightened, the ends must be kept in exact apposition with a pointed probe, and not allowed to override one another. In this method and in the others which follow, care must be taken not to insert the sutures too near to the tendon ends—*i.e.*, when there is any tension, not nearer than one-third or even half an inch; finer sutures may then hold the ends exactly together—owing to the muscular tension and the tendency of the suture to cut through the parallel fasciculi and their uniting connective tissue.

FIG. 26.



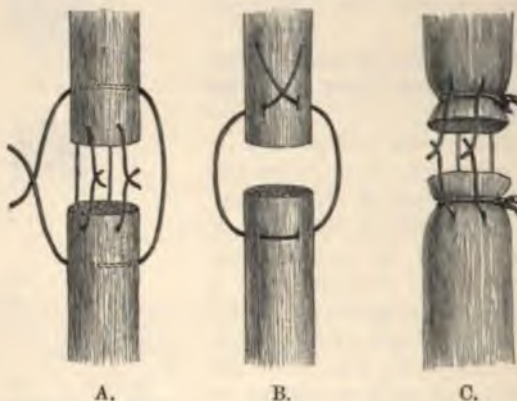
Wölfler's transverse tendon-suture (*Wien. Med. Woch.*, 1888, 5. 1). When the ends touch, the inventor calls his method "direct transverse tendon"-suture, and gives it the name of "indirect" when the ends cannot be brought together, and the threads are tied and left to form guides for the development of fibrous connecting bridges.

Another method which may be employed where the tendon is round and large is that of Wölfler (Fig. 26) or of Trnka (Fig. 34, b).

(2) *Where the tendon is flat, e.g., on the dorsum of the hand, a very common site for tenorrhaphy.* Here there is much tendency for the suture to cut its way out if inserted in the ordinary manner. One of the following methods—viz., Wölfler's, Le Fort's, Le Dentu's, which are made plain in Figs. 26 and 27—will be found preferable.

(3) *Where the tendon is round and small, too small for the methods of Wölfler or Le Dentu, and where, owing to the size of the tendon and the traction, a suture inserted in the ordinary way will cut out, that of E. Schwartz, may be tried (Fig. 27) or, better, that of Watson Cheyne and Burghard (4).* A circular ligature of silk is thrown round each of the tendon ends, and two vertical loops passed above and below these ligatures, and thus prevented from slipping, serve to draw the

FIG. 27.



A. Le Dentu's method of tendon-suture. B. That of Wölfler. C. E. Schwartz's method.
(Le Dentu and Delbet, *Traité de Chir.*, t. iii. p. 825.)

ends together. Circular ligatures thus employed would seem likely to endanger the nutrition of the tendon ends.

(4) Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii. p. 228), advise the following method, which will be seen to escape the above objection to Schwartz's method, while it meets the tendency of ordinarily applied interrupted sutures to cut out too quickly, though this may be largely obviated by passing the sutures sufficiently far from the tendon ends:—"The best plan is to pass the needle across from front to back through the whole thickness of the tendon quite to one edge of it and close to the line of division, and then to tie the thread over the small piece of tendon included in the loop. Although the piece of tendon below the ligature may possibly die, a secure hold is thus obtained, which may be pulled on firmly without fear of the thread cutting its way out. The same procedure should be adopted also on the opposite side of the tendon, and both the upper and lower ends should be prepared in this way, care being taken that the stitches are inserted at exactly corresponding points in the two ends, so that the tendon is not twisted when

they are tied together. The ends of the corresponding threads on either side of the division are then tied sufficiently closely to bring the two cut surfaces in apposition. It is well to put in one or two stitches in the centre to reinforce the lateral ones; these will prevent the cut surfaces from being displaced laterally or curled up, and as they do not bear any strain, they may be inserted in the usual manner."

In addition to any of the above methods the surgeon may wisely make use of one or more **sutures of support**, *i.e.*, sutures whose object is to relax tension. A suture is made to traverse first one tendon and then the other a full inch or more from the ends, the sheath also being included so as to secure a firm hold, and the ends then knotted in the usual way.

The wound is closed with or without drainage, according to its condition, the amount of disturbance, the probable after-collection of blood, &c.; where there is the very least doubt, drainage should be employed. The dressings should be applied in sufficient quantity and uniformly so as to distribute any oozing evenly throughout them. If possible, they should be left on for seven or ten days. The limb must be arranged on a splint in such a position that no undue tension falls upon the united tendons, while at the same time the comfort of the patient is attended to. A perforated zinc trough, which is readily cut, fairly easily bent and moulded to any degree of flexion, and which can be boiled, will be found useful in the common cases of tendons injured about the wrist, where the elbow, wrist, and fingers must be kept flexed. Poroplastic or gutta-percha are other materials which will be useful. If wooden splints be employed, a Carr's splint is comfortable, but must be reinforced by a lateral angular splint at the elbow. Wooden splints are, however, much less efficient, in that they fail to secure the needed amount of flexion, or the power of modifying this later on. The patient's comfort will be greatly promoted by taking the splint off every two days and altering the angles slightly. Restlessness, while the anæsthetic is recovered from, must be prevented, as, if the sutures do not hold, the parts will tend to heal in one contracted mass. Most careful attention will be needed afterwards in the employment of carefully begun and perseveringly continued passive and active movements. In commencing movements the surgeon has, on one hand, to prevent the formation of adhesions; on the other, he must remember the risk of breaking down the recently formed union. The date must vary with each case, but, as a rule, in the case of the tendons of the fingers, passive movement may be begun, very gently so as not to strain the union, about the sixth day, and gradually increased. From the fourteenth to the twenty-first day will usually be early enough for the commencement of active movements. Soft adhesions will certainly have formed, but if the sutures have been so placed as to secure a firm hold, and if the wound has run an aseptic course, there is little risk of the union being broken down.

In cases of secondary tendon-suture, as in that of nerves, the result may be disappointing for some months; but if the tension was not extreme, and if the wound ran an aseptic course, the final result will probably be satisfactory, if the patient does his best to help the surgeon.

I would take this opportunity of saying that, in the treatment of an incised wound of the hand or foot, the condition of the tendons should

be cleared up as well as that of the vessels. The practitioner too often rests satisfied with arresting the urgent hæmorrhage. The wound heals quickly, but loss of power remains. The following is a good instance:—

In August, 1888, H. P., æt. 31, was sent to me with constant flexion of, and inability to extend, the last two phalanges of the thumb. A few months before he had been treated for severe hæmorrhage from an incised wound of the dorsum over the first phalanx and metacarpal bone of the right thumb. By dissection the extensor secundi internodii was seen to be divided, the upper end being found by following up the sheath. The extensor primi had been only partially divided for three-quarters of its width. When trimmed the two ends of the extensor secundi were separated by an interval of an inch on complete extension of the thumb. Use of a stout silk suture, and pushing down the upper end of the tendon, left the ends still separated by a quarter of an inch; two very fine silk sutures brought the ends into good, but not exact, apposition. On hyper-extending the thumb the V-shaped notch in the partially divided extensor primi was obliterated, so no sutures were used here, the edges of the notch being merely refreshed. A splint was applied on the palmar aspect, so as to keep the thumb hyper-extended. Morphia was given at first. When the patient was seen, two months later, he had recovered complete extension.

B. Cases where only one end can be found.

The distal or fixed end of the tendon can nearly always be found. To meet the difficulty, often extreme, of finding the retracted upper

FIG. 28.



Buttonhole method of tendon-anastomosis. Method of MM. Tillaux and Duplay.
(Duplay and Reclus, *Traité de Chir.*, t. i. p. 825.)

end of one of the flexor tendons, M. Félizet (*Bull. et Mém. de la Soc. de Chir.*, t. xix. p. 610, 1893) advises, if slitting up the sheath and methodically pressing down the muscular belly are insufficient, that the upper end may be made to emerge into view, and further disturbance of the parts avoided, by extending the adjacent fingers. By this step what M. Félizet terms the little fibro-serous vincula, which tie together adjacent tendons, are drawn upon and pull down the upper end of the severed tendon into view. Another alternative is given by Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. ii. p. 228), to be employed where the slitting-up of the sheath would have to be very extensive, and might involve danger to important structures. "A second incision is made over the tendon, well above the wound, and the sheath opened; from this incision the tendon is pushed down until its divided end appears in the original wound." In cases where difficulty is experienced in finding the distal end, *e.g.*, where in a secondary operation for divided tendons at the wrist, this distal end is lying behind the annular ligament, the same writers advise

as follows: "A better plan than dividing the annular ligament is to cut into the palm and expose the tendon well on the distal side of the division; then, by pushing a probe up the sheath, the point at which adhesion has taken place may be found, and an attempt made by pushing the probe upwards through the adhesions, to make it protrude into the wound, and form a guide along which the tissues can be turned aside until the end is got at." In every case of difficulty, as soon as a tendon end is found it should be secured at once by tenaculum-forceps or silk. If, after careful search, sufficient slitting-up of the sheath, &c., it is still impossible to find the upper end, the lower end may be successfully attached to a neighbouring tendon by **tendon-anastomosis**. This is effected (1) by suitably preparing the contiguous lateral margins. (2) by fixing the severed end in a *buttonhole* made in an adjacent tendon (Fig. 28).

(3) **Anastomosis by Bifurcation or Splitting of a Tendon.**—Thus M. E. Schwartz, in a case where the proximal ends of two of the extensors of the thumb could not be found, united the peripheral ends to the extensor carpi radialis longior, which was split longitudinally and in part sutured between them (Fig. 29).

The following case (Dr. v. Fillenbaum, *Wien. Med. Woch.*, Nos. 29 and 30, 1885) is a good instance of the success of the last step, and of one means of employing *sutures* so as to prevent tension:—

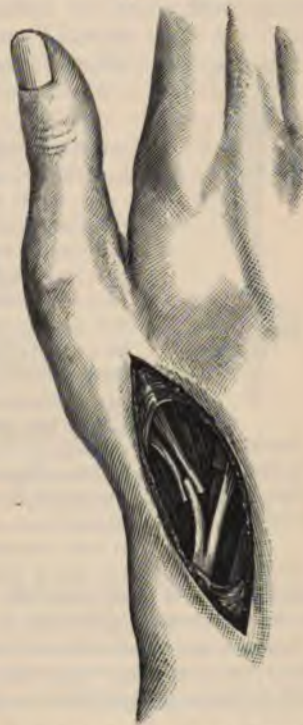
An oblique cut with a bread-knife involved the common extensor of the index and middle finger, and the extensor indicis, the central end of the latter retracting so far that it could not be reached, unless by slitting up its sheath. The tendons of the common extensor were each united by two fine silk sutures.

The accessible peripheral end of the extensor indicis was attached to both ends of the sutured tendon from the extensor communis to the index finger. The strongly stretched extensor tendons of the second and third fingers were now fixed (to prevent retraction by muscular action) by silk sutures passed, 2 cm. higher up, through skin and tendon-sheath, and tied over a roll of iodoform gauze. These were removed on the fifth day. Passive movement was begun on the sixteenth day. Six months later the man had perfect use of his fingers.

If it is the proximal end which is alone accessible this must be sutured to an adjacent tendon, the action of which it will reinforce, without regaining its own special function. This must be looked upon as a last resort.

The back of the hand is the "seat of election" for the anastomosis of tendons, as they are here united by fibrous expansions. Thus a

FIG. 29.



Tendon-anastomosis by splitting or bifurcation of an adjacent one. Method of M. E. Schwartz. (Dentu and Delbet.)

neighbouring tendon can be relied upon to render active the peripheral end of another tendon whose central end cannot be found. Furthermore, it is on the back of the hand, and especially near the knuckles, that operations on tendons give the best results. Retraction is less here than elsewhere, owing to the presence of connecting bands and expansions to the joint-capsules; there is less bleeding; the skin is thinner, and its greater mobility renders less harmful the formation of any adhesions.

But while tendon-anastomosis is especially applicable to the extensors, the following shows that it may also be employed in the case of one of the flexors, the tendon of the flexor longus pollicis having been joined with the index tendon of the flexor profundus, with marked success, by Mr. F. T. Paul (*Liverpool Med.-Chir. Journ.*, 1895, p. 500):—

FIG. 30.



Tendon-lengthening by Czerny's method. (Dentu and Delbet.)

A boy, *set.* 7, falling with a cup in his hand, had sustained a severe cut across the ball of the right thumb. There was no power over the last joint, and consequently no power of holding anything—*e.g.*, a pen, in the usual way. An incision over the flexor longus revealed the distal end of the tendon in good condition and firmly attached to the scar. This end having been isolated, the central end was sought for, but, though the incision was prolonged an inch above the annular ligament, no trace of it could be found. It was quite useless to search higher, since, if found, the tendon would be too short to bring down and attach to the distal end. Under these circumstances Mr. Paul decided to endeavour to obtain a union between the terminal end of the flexor longus pollicis and the side of the index tendon of the flexor profundus; a step which, if successful, would give the patient a power of flexing the thumb and forefinger together, and thus of holding articles between them. The free end of the thumb tendon was cut into a wedge-shape, and inserted into a notch made in the side of the index tendon, where it was retained by two or three very fine sutures. The wound

healed by first intention, and a year later it was found that not only had the boy the combined power of grasp hoped for, but that, under training by a skilled pianist, he was obtaining independent movement of the thumb and forefinger. The fact that, while the boy had only one muscle between the two digits, he could yet flex them separately, was entirely due to training of the extensors. Thus, if told to bend the thumb alone, he would fix the forefinger by its extensor, and then flex the thumb, or the reverse.

C. Cases where both ends can be found but it is impossible to adjust them.

This difficulty is usually met with after the removal of a growth from a tendon, and in some cases of secondary tendon-suture. The following methods are available.

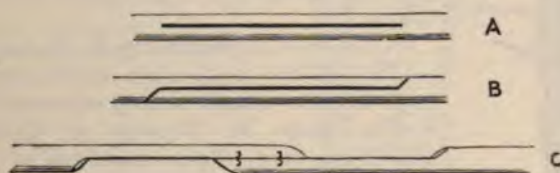
i. Tendon-lengthening.

a. *Method of Trnka* (*Centr. f. Chir.*, No. 12, 1893) (Fig. 34).—This is most applicable to stout tendons. When this method is employed, the incision must not be carried too near the end of the tendon, and to prevent this being detached by any tension that the strip will be called upon to bear, it will be well to secure it above as well as below by one or more sutures (Fig. 34, a).

b. *Method of Czerny* (Henck, *Centr. f. Chir.*, No. 18, 1882).—Czerny, in a case in which one of the extensors of the thumb had

been divided, doubled down a slip of the peripheral end, as shown in Fig. 30. But during this step the slip became entirely detached, and then had to be treated as a true graft. If this method be employed, a suture should be inserted at the angle where the slip is turned down, so as to prevent its being stripped away. The method of Trnka (Fig. 34) is intended to prevent the accident which is likely to occur in that of Czerny. A transverse incision is made between one to two inches above the free end of the proximal part of the tendon according to the size of the gap to be filled without tension. This incision only goes across half of the tendon, and from this point the latter is split vertically downwards along the middle line as far as a point from a quarter to a half an inch from the cut end. A flap is then turned down, care being taken that it is not detached, and, to meet any future tension at what must be a weakened spot, one or two sutures of fine sterilised silk are passed in the angle between the flap and the tendon, and securely tied. If it is found necessary a like flap is turned up from the distal portion of the tendon. Here the advice of Messrs. Watson Cheyne, C.B., and Burghard (*loc. supra cit.*, p. 231), should be followed,

FIG. 31.



One method of tendon-lengthening. A. Tendon split longitudinally. B. Section completed by incisions at ends of fissure. C. Divided tendon elongated and sutured. (Anderson.)

and the two flaps should be cut long enough to overlap so that additional sutures can be placed between the adjacent sides of the flaps. Here as in all cases where the newly united tendons are submitted to some tension, the parts must be kept fully relaxed for a sufficient time, active and passive movements begun very gently, and increased very gradually. Where many tendons—*e.g.*, the flexors of the wrist—have been lengthened, it may be wise to defer active movement for a fortnight.

c. Where the tendon is fairly thick and rounded, the following method of tendon-lengthening of Mr. Anderson's may be made use of: In flat and easily frayed-out tendons sloughing would probably follow on so much manipulation of each end. The gap that remains between the two ends of the tendon having been carefully measured, each tendon is split accurately in the middle line, care being taken not to bring the split too near to the end of the tendon. At the two ends of the above incision section of the opposite halves of the tendon is made, as in Fig. 31.

d. *Tendon-lengthening by Zig-zag Incisions* (Fig. 32).—M. Poncet, of Lyons, has shown (*Gaz. Hebdomadaire*, 1891, p. 575) that this method may be successfully employed in cases where, owing to the tension

threads which have been inserted in the ends of the tendons threaten to cut through.

In the first case, that of a boy whose tendo Achillis had just been severed, M. Poncet, in order to diminish the tension necessary to bring the ends together, made, on the upper end of the tendon, two cuts in zig-zag fashion, each passing a little more than half across the width of the tendon. Marked elongation of the tendon followed, and it was then easy to suture the ends without tension. The boy was allowed to walk on the twenty-eighth day, and left the hospital about seven weeks after the injury, walking being almost perfect.

FIG. 32.



Tendon-lengthening by zig-zag incisions. (Poncet.)

While this method is especially applicable to the tendo Achillis from its size, M. Poncet has also used it in the case of the extensor indicis.

In this case also two zig-zag incisions on the upper end of the tendon enabled the suture, which had previously threatened to cut out, to be inserted without any tension.

The incisions should pass through at least half the width of the tendon, and include both this and its sheath. There is no risk of the tendon sloughing if antiseptic precautions be taken.

e. Tendon-lengthening by the Z-shaped Method.—This will be made plain by Fig. 31.

f. Tendon-lengthening by means of Osteotomy.—The same M. Poncet, of Lyons (*Revue d'Orthop.*, July, 1891), made use of the following ingenious method in uniting a severed tendo Achillis (Fig. 33):—

Forty days after the injury (by an axe) the wound was healed, but the ends of the tendon were 3 cm. apart, and the lameness was very disabling. A U-shaped flap having been turned off the back of the heel, a slice of the os calcis was then vertically detached with the saw; when quite loose it was glided upwards, and the lower part of it fixed to the upper part of the sawn surface with an ivory peg. The ends of the tendon could now be brought into close apposition without undue traction. The result was perfect.

ii. Distance-Sutures.

MM. Anger, Forgin, and Assaki were amongst the earliest workers on this subject.

a. Distance-Sutures alone.—In some cases (the earliest being one of M. Anger's) where the ends of the tendon could not be adjusted, and suture-loops have been passed and knotted between the widely separated ends, these sutures have appeared to diminish muscular tension on the tendon ends, and to help in directing the reparative process.

This method of **distance-sutures** seems to have been employed in this country as long ago as 1889, by Mr. Gostling, of Worcester (*Lancet*, ii. 1890, p. 767), in a case of injury to the extensors of the thumb.

Eleven weeks before, while the patient was pruning roses, his knife inflicted a wound, the scar of which, an inch long, was found about an inch above the base of the metacarpal

bone of the left thumb. Just below this scar the distal end of the extensor primi and ossis metacarpi pollicis could be easily felt, but the proximal ends could only be indistinctly made out, five inches off, on the back of the forearm. The left hand was of little use, the thumb being flexed and adducted into the palm. An incision exposed the distal ends at once, but the synovial sheath was blocked at the scar for three-quarters of an inch by a mass of connective tissue. This was cut through and the sheath slit up until the proximal ends of the tendons were found. All four ends were smoothly rounded off, and no adhesion had formed. As the ends were five inches apart it was impossible to bring them nearer together than three-quarters of an inch. The ends having been pared, they were stitched together with two catgut sutures each. The wound healed by first intention, and, six months later, all the movements of the thumb were perfect.

In 1886, Wölfler successfully combined the method of *distance-suture* and attaching the ends of the severed tendons to adjacent sound ones.

The patient had had all the tendons of the extensor communis severed. He was unable to extend the middle and ring fingers, but retained this power over the index and little fingers. At the operation, two months after the injury, it was necessary to divide the posterior annular ligament in order to find the central ends of the tendons. As the separated stumps were 8-9 cm. apart, direct union was hopeless. The ends were joined by indirect transverse sutures of silk and catgut, the loops being 8 cm. long. The four central and peripheral tendon ends were also united to the adjacent uninjured tendons, two to the extensor indicis and two to the extensor minimi digiti. Though the wound healed without suppuration, the silk thread-loops were cast off unaltered. Ten days after the operation the patient began to extend his fingers, and he ultimately regained extension of each individually, as in the uninjured hand. This good result must have been due to the fibrous tissue which had been developed in the place of the catgut and silk threads, and not to the joining of the tendons to those which were intact.

M. Glück, who has employed the method of *distance-sutures* with marked success in several cases, used it in one instance, not for filling up a gap in a tendon, but for replacing an end which was lost (*Semaine Médicale*, 1892, p. 198).

A boy suffered from injury to the tendons of the extensor indicis and communis. M. Glück firmly tied the central ends of the tendons with loops of silk, and carried them forward to their points of insertion, where they were fixed by means of a steel needle. The first trial failed, the sutures tearing out. A second operation succeeded. When the needle was removed, at the end of four weeks, both the middle and terminal phalanges could be extended.

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FIG. 33.



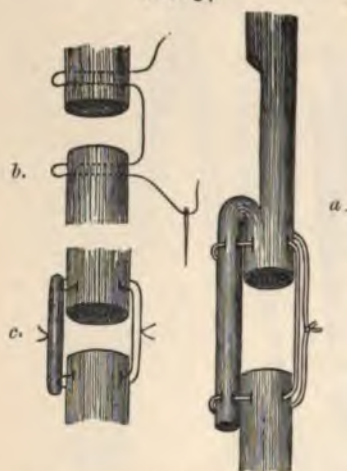
Suture of tendo Achillis by partial detachment and sliding upward of the os calcis. Poncet's method.

(Duplay and Reclus.)

b. Distance-Sutures together with Bundles of Threads of Silk and Catgut (Fig. 34).

In a case in which the two ends of the flexors of the middle finger were widely separated after an injury, M. Glück (*loc. supra cit.*) was able to remedy a gap of 10 cm. (= 4 in.) by substitution of threads of silk and catgut. Healing by first intention and perfect restoration of movement followed. It was thought that in this case a gradual substitution of the catgut by connective tissue took place.*

FIG. 34.



Different methods of tendon-suture. (Trnka.) In the right-hand figure, *a*, where the ends of the tendon cannot be brought together, tendon-lengthening (p. 46) has been employed on one side, and some catgut strands—a form of distance-suture (p. 48)—on the other. In the left-hand figure a form of transverse suture is shown above, *b*; below, *c*, distance-sutures consisting of different thicknesses of catgut have been used

that of a cat, into the gaps between divided tendons in man. A fair amount of flexion was obtained.

It remains to be seen how far this method will supersede that of distance-sutures (p. 48). Such grafts probably act as conductors only in the process of formation of new fibrillæ. The method is somewhat troublesome, and can obviously only be practised under limited conditions, and, in the case of tendons from animals, only when the needful preparations can be made. Even if no suppuration occur, it is always possible that the piece of tendon, especially if of any size, will merely act as a tediously disappearing foreign body.

* In some cases the sheath may be used to supplement the distance-sutures. After the tendon ends have been mobilised, any remnants of the sheath are dissected free, and so sutured as to help in forming a canal along which the new formation of connective tissue may take place. This subject is again referred to at p. 58.

In other cases the foreign body employed remains long encysted in a sheath of connective tissue. Strict asepsis is, of course, essential.

iii. Tendon-grafting, properly so called.

Here a part of another tendon, from the same patient, in cases where there has been an extensive injury, as in a partially crushed hand, or a tendon from the rabbit, is made use of.

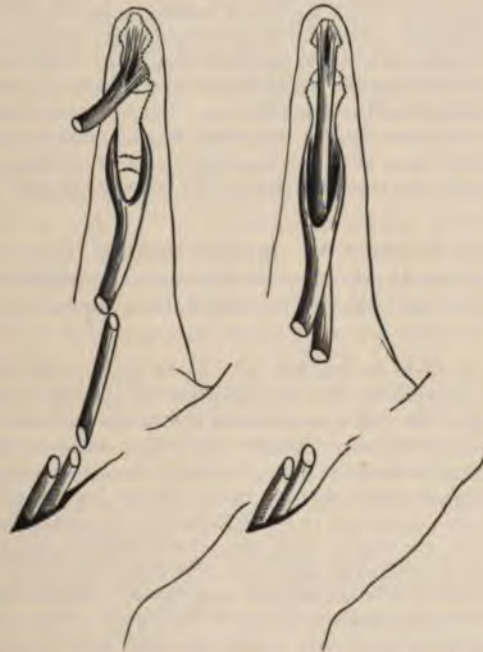
Mr. M. Robson (*Clin. Soc. Trans.*, vol. xxii. p. 291) successfully grafted $4\frac{1}{2}$ inches of a flexor tendon from a finger too much smashed to save, on to the dorsum of the hand, so as to form a new extensor for the index finger, the tendon of which had been completely torn away. The proximal end of the tendon was stitched to the fleshy belly of the extensor communis, where the tendon had been previously attached, the distal end being fixed to the small portion of tendon left near its insertion into the phalanx. The case, which is an excellent instance of conservative surgery, ended in recovery with a most useful hand. During extension of the index the new tendon could be felt to move under the skin.

M. Peyrot (*Bull. de la Soc. de Chir.*, 1886, p. 357) transplanted in one case the tendon of a dog, and in another

Dr. V. Rochet, of Lyons, has published (*Gaz. Hebdomadaire*, 1891, p. 293) a case in which he practised successfully a method of *tendon-grafting*, which he called *autochthonous*, the graft being taken from one of the divided tendons themselves (Fig. 35). This method is especially applicable to the flexor tendons of the fingers.

The patient had, two months before, suffered division of the flexor tendons at the root of his right index. The two lower phalanges were constantly extended, all power of flexion being lost. The parts having been rendered evascular, an incision over the site of injury showed that an interval of 6 cm. existed between the cut ends of the flexor

FIG. 35.



Autochthonous tendon-grafting. (Rochet.) To the right is seen the gap between the tendons found on exploration; to the left the manner in which it was filled up.

tendons, and that by no means could this distance be reduced to less than 2 cm. To fill this gap, Dr. Rochet made an incision over the lower part of the middle phalanx and the base of the last, just where the flexor profundus emerges from between the two slips of the sublimis. He divided the former, and then, returning to his first wound, drew the piece of the flexor profundus, which was now cut above and below, out into the first wound, the attachments of the tendon to the sheath yielding readily. The lower end of this tendon-slip was then sutured to the lower end of the flexor sublimis, and its upper end to the muscular ends of the flexor sublimis and profundus—directly to the former tendon, and laterally to the latter. Lastly, the small slip of flexor profundus, which had been left attached to the last phalanx, was sutured to the two slips of the flexor sublimis a little above its insertion into the second phalanx. The wound healed quickly, and on the fifteenth day some power of flexion was already present. Later on the second phalanx could be flexed as freely as its fellow. Flexion of the third phalanx was more limited, this not passing beyond a very obtuse angle.

Dr. Rochet observes that it would be possible to carry out the above method by taking the graft or slip from the upper end of one of the lower parts of the divided tendons

without interfering with its insertion, which involves making a fresh wound. Later Lange followed Gluck and Wolfier (*Munch. Med. Woch.*, May 27, 1902) with artificial tendons of silk in order to elongate transplanted hamstring tendons (p. 57 and Fig. 38).

M. Desquin (*Belg. Med.*, Dec. 24, 1896; *Epit. Brit. Med. Jour.*, Jan. 23, 1897) has devised another method of tendon-grafting, by which the use of a finger flexor was restored.

A carpenter, 25, had the right middle finger in permanent extension, owing to the severance of the flexor tendons by broken glass. The man came to M. Desquin, thirteen months later, seeking amputation. A very free incision having been made along the course of the tendons in the finger and in the palm, it was found that 4 to 5 cm. of the superficial tendon were wanting. It was impossible to find the deep tendon.* By strong traction on the central end of the superficial tendon, seized in the palm, it could be brought in contact with, and sutured to, the phalangeal end. This could only be done by strongly flexing the finger, and it would have been impossible to unite the superficial parts over the strongly stretched tendon. Returning to the wrist, therefore, the operator divided the tendon with a small piece of muscle adhering. The finger was then extended and the tendon just divided stitched to that for the index finger, so that the flexor for the latter, on its contraction, acted upon both fingers. The result was perfect. After four weeks the fingers could all be flexed simultaneously, or the index and middle together, the others remaining extended.

The following instance of tendon-grafting as a substitute for amputation, in cases where suppurative teno-synovitis or deep whitlow has destroyed the tendons, is recorded (*loc. supra cit.*) by the same author :

The patient, 19, could not flex his right index finger owing to destruction of the flexor tendon by a deep whitlow. Some weeks after the healing of this, an incision was carried from the pulp of the index finger along the normal course of the tendons to just above the wrist-joint. In the palm the fascia was divided, and above the annular ligament the common flexor sheaths were opened. The search for the tendon ends proved easy below, where a few tags remained adherent to the phalanx, but difficult at the wrist. At length one was found which wanted 10 cm. of its length. To supply the gap an equivalent of the superficial flexor was taken. This was severed near its origin, and drawn down strongly until it could be sutured peripherally. The upper end of its lower segment was then stitched to the lower end of the deficient deep flexor. Despite some suppuration and the exposure of the transplanted tendon, for a week, over a small distance in the first phalanx, where the incision had divided purely cicatricial tissue, no exfoliation followed. Two years later, flexion of the finger was performed as freely and strongly as in the others.

Resection of Bone in aid of Tendon-suture.—It will suffice merely to allude to this method, which can only rarely be justifiable. K. Lobker (*Centr. f. Chir.*, 1884, No. 50) seems to have been the first to make use of it. In a case of long-standing division of the tendons above the wrist, portions of the radius and ulna were resected. The result was only a partial success, and the bones took three months to unite firmly. Mr. T. P. Rowlands has used this method most successfully (*Lan.*, Oct. 21, 1905). His paper will well repay perusal.

Tendon-shortening.—This may be occasionally called for in some cases of acquired talipes calcaneus, where the tendo Achillis is elongated. As these cases usually date to infantile paralysis it will be well to bear in mind the advice given by Mr. Walsham (Walsham and

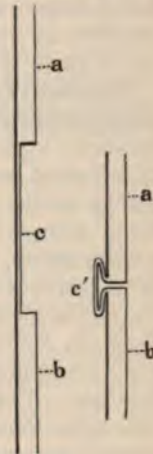
* No explanation is given of this and the above-mentioned gap in the superficial tendon. The original wound had healed by first intention.

Hughes, "The Deformities of the Human Foot," p. 380): "Shortening of the Achilles tendon is only of service when some muscular tissue remains in the gastrocnemius and soleus. When these muscles are completely paralysed and have undergone fatty degeneration, the shortening of the tendo Achillis is useless. At the time of operation, and for some time subsequently, the foot is held in better position; but as soon as the patient begins to walk, the fatty muscle gradually yields, and the condition of the muscle is soon as bad as before the operation. Prior, therefore, to undertaking the shortening of the tendo Achillis, a very careful examination of the electrical condition of the calf muscles should be made, and if it is clear that complete degeneration has taken place, no operation should be undertaken.* Conversely, if the electrical examination shows that there is some healthy muscle tissue left, it is well to postpone the shortening of the tendon till as much good as possible has been obtained by a systematic course of electrical treatment, combined with massage of the calf-muscles." In suitable cases the tendo Achillis may be shortened by one of the following methods.

(1) **Willet's Method** (*St. Bartholomew's Hospital Reports*, vol. xvi. p. 309).—"A Y-shaped incision, some two inches in length, is made over the lower end of the tendo Achillis down to the tendon. At the lower or vertical point of the incision the dissection is continued until the tendon is fully exposed over its superficial and lateral surfaces for the space of one inch in length, its deep connections being left undisturbed. The tendon is now cut across at the point of junction of the oblique portion of the wound with the vertical. Next the proximal portion of the tendon is raised, with its superficial connections to the integument undisturbed, to the extent of fully three-quarters of an inch, by dissecting along its deeper surface, *i.e.*, by reversing the dissection made upon the distal segment. A wedge-shaped slice of the tendon is now cut off from both segments, that from the proximal being removed from the deep surface, whilst from the distal it is taken from the superficial; in both instances the face of the wedge-shaped portion removed being at the point where the tendon has been divided. The heel being now pressed upwards, the proximal portion, including both skin and tendon, is drawn down and placed over the distal, thus bringing the prepared cut surfaces of the tendon into apposition. In this position they are held by an assistant whilst four sutures, two on either side, are passed deeply through the integument, then through both portions of the tendon, and again out through the integument, and fastened. When the operation is completed, the united edges of the wound assume a V-shaped appearance, owing to the angle of the proximal portion being now attached to the terminal point of the distal portion of the original incision."

Mr. Willet believes the method of merely removing a piece of the

FIG. 36.



* The only operative steps advisable here will be transplantation of a healthy tendon, *e.g.*, peroneus longus and brevis into the tendo Achillis (pp. 56 and 58).

tendon and suturing the divided ends to be faulty. The cicatricial tissue filling up the gap will, he says, be merely fibrous tissue, and not homogeneous in structure with the tendon, and, therefore, likely to yield. For the Z-shaped method, see "Lower Extremity."

(2) **M. Ollier's Method of Tendon-shortening without interrupting its Continuity** ("Traité des Résections," t. ii. p. 473).—When the tendon is large he removes with a very small bistoury the central part. A window having been thus made, the upper and lower ends are brought together with sutures, and the lateral bands folding upon either side contribute to the joining of the two ends.

Where the tendon is narrow, instead of making a window, M. Ollier adopts the plan shown in Fig. 36. In either case sutures of fine sterilised silk should strengthen the spot where the folded portions join the main tendon.

It will be convenient to study here, owing to their association with operations on tendons, the surgical relief of Infantile paralysis, Spastic paralysis, and the so-called Ischæmic paralysis, though most of these concern the lower extremity. Arthrodesis, or the artificial stiffening of flail joints, which has often to be combined with transplantation of tendons in infantile paralysis, will be considered in the Surgery of the Lower Extremity (*q.v.*).

Tendon-Transplantation, more especially in relation to its employment in Infantile Paralysis.—The object here is to reinforce a paralysed muscle by attaching to it one or more tendons of adjacent healthy muscles. This method deserves an extended trial, owing to the great frequency of infantile paralysis, especially in our large towns; the life-long crippling which it entails, including, not unfrequently, it should be remembered, amputation in early adult life on account of established trophic ulcers; the expense otherwise involved by mechanical treatment, extending as this usually does over a lifetime (R. Jones); the limited amount of good which other operations—*e.g.*, tenotomy—usually effect; and the fact that transplantation of tendons, of itself not a severe operation, can be employed early in life, when the muscles on which additional work is placed have still natural growth to make, and when at the same time the paralysed muscles have not yet had time to undergo those secondary changes which are so baffling to the surgeon. On the other hand, I need only allude to the discredit which will fall upon this method if the conditions which surround it, owing to the pathology of the disease which may call for it, are forgotten, if too much is expected of it, if operations be performed indiscriminately, if no definite plan is formulated, based on very careful previous examination, before any transplantation is undertaken, and if the need of unremitting after-attention for long periods be lost sight of.

As long ago as 1882 Nicoladoni (*Arch. f. klin. Chir.*, Bd. xxvii. S. 660) recorded a case of paralytic talipes calcaneus in which he reinforced the T. Achillis with the two peronei, with a good result. Drobnik, of Posen, published in 1892 (*Zeit. f. Chir.*, Bd. xliii. S. 473) the first series of cases, sixteen in all. Dr. Milliken (*New York Med. Record*, Nov. 28, 1896) and Dr. E. H. Bradford, Surgeon to the Children's Hospital at Boston (*Ann. of Surg.*, Aug., 1897) were amongst the pioneers in this work in America. In this country first

Mr. R. J. Jones, of Liverpool, and later, Mr. A. H. Tubby, have brought this method of treatment of a very disheartening disease prominently before the profession in the *Medical Annual* for 1889 and the *Liverpool Medico-Chirurgical Review*, 1899, p. 270, and more recently in their "Surgery of Paralyses," 1903. The credit of whatever time proves to be of real value in the account that follows must be given to these writers especially.*

Tendon-Transplantation, Preliminary Points in (Tubby and Jones, p. 159).

"Before it is decided to perform the operation the case must be carefully studied, and a definite plan of procedure formulated. The electrical reactions of the muscles should be previously ascertained, and an attempt made to estimate the strength of those which it is intended to transplant. In the case of the foot all secondary conditions, such, for instance, as contraction of the plantar fascia, should be remedied. For mechanical reasons it is advisable to select the reinforcing tendon from a muscle whose line of action is as nearly as possible parallel with that of the muscle to be reinforced. For instance, in a case of paralytic valgus it may be better to graft a strip of the T. Achillis into the tibialis posticus rather than to bring the tendon of the peroneus longus across the front of the ankle, and into the tibialis posticus. It is also important to remember that muscles, which before the operation appear to be hopelessly paralysed, exhibit after the operation signs of returning strength. The operation is rarely called for when only one muscle is paralysed, nor should it be done when nearly all the muscles round a joint are implicated. The latter cases are suitable only for arthrodesis (*q.v.*, Operations on The Lower Extremity), and, indeed, there is a fear that an indiscriminate use of transplantation may lead to unsatisfactory results, and so bring the operation into undeserved discredit. A great point is the careful choice of cases."

The selected muscle should belong, if possible, to the same group as the paralysed one, because it is nearest, and restoration of voluntary function is thus more quickly and perfectly secured. "The reinforcing tendon should be carried as directly as possible to the paralysed muscle, and not bent round at an angle, a manœuvre which has the effect of considerably lessening the transfer of power. For instance, if the peroneus brevis were used to reinforce the extensor communis digitorum, the former should be attached to the latter above the ankle, and not below and in front of the external malleolus. When an opponent of a paralysed muscle is selected, it gives emphasis to this principle, namely, that by selecting one of the opponents of a paralysed muscle we not only reinforce that weak muscle, but we lessen the antagonism which exists between the two groups. And by transferring, for example, the insertion of the peroneus longus in a case of paralytic talipes valgus from the outer to the inner border of the foot, we effect an equality between the forces acting upon the two borders. Finally, it is unnecessary in these days to insist upon the absolute necessity of perfect asepsis, inasmuch as the success of the operation depends upon healing by primary union."

Technique of the Operation (Tubby and R. J. Jones, *loc. supra cit.*, p. 161).—"After the parts have been rendered completely aseptic, and if obscuring hæmorrhage be feared, an Esmarch's bandage† has been applied, an incision‡ is made suitable in length and in position to give free access to the tendons. In many cases a single incision will suffice, but it sometimes happens that, to avoid a single large incision, two smaller ones are made, *e.g.*, when the peroneus longus is transferred to the inner border of the foot. In this case one

* Mr. Eve (*Brit. Med. Journ.*, 1898, vol. ii. p. 1140) and others have published cases which will repay perusal.

† The employment of this bandage will interfere somewhat with estimating the colour of the muscles, a test which is helpful sometimes (*vide infra*). The hæmorrhage in the case of longitudinal incisions, which should always be preferred, is usually slight.

‡ Where several tendons are operated upon, and one or more lie far apart, a flap-division may suggest itself. A caution given by Mr. Eve (*loc. supra cit.*) should be remembered here; any extensive division of veins will lead to troublesome œdema of the foot.

incision is made over the front of the fibula, and a second over the scaphoid.* By burrowing through the subcutaneous tissues of the dorsum of the foot with a director, a channel is made for the passage of the tendon to the scaphoid. It is curious to remark that no adhesion of the transplanted tendon takes place to the subcutaneous tissue, doubtless from the endothelium on its surface; hence we learn the necessity of handling the tendons very carefully. If difficulty exist in ascertaining whether the muscle is paralysed or not, the following description of the appearances may be of some assistance. The healthy muscle is always deep red, firm and elastic. The paralysed muscle is reddish-yellow, often shows signs of fatty degeneration, and is lax. It is well to have at hand the constant current battery, with electrodes capable of sterilisation."

A simple example, *e.g.*, the implantation of the peroneus longus into the tendo Achillis for T. Calcaneus will illustrate the operation (Fig. 39). "The tendons are exposed by an incision about four inches long, made between them and above the external malleolus. The sheaths being opened, a longitudinal incision is made through the tendo Achillis at its

FIG. 37.



The peroneus longus tendon has been drawn through and fixed on to the back of the tendo Achillis. The ends of the peroneus tendon are sewn on to the back of the tendo Achillis at D and E, having been first drawn through the tendon at C. (Tubby and Jones.)

thickest part. The peroneus tendon is then severed just above the malleolus, care being taken that there is sufficient length to be passed through the tendo Achillis, and to allow of the end of the reinforcing tendon being pleated down on to the tendo Achillis (Fig. 37). Lateral attachment is not so satisfactory. The foot should now be placed in the position which it is desired subsequently to obtain—that is, somewhat in equinus. A silk suture having been threaded through the end of the peroneus tendon, it is drawn through the tendo Achillis from the front to the back, and then pleated down on the posterior aspect."

"A very important question arises as to the tension of the reinforcing tendon at the time of stitching. Over extension is to be avoided, because experience has shown that the muscle loses its contractile power subsequently." The two authors quoted above are accustomed to pull upon the proximal end of the tendon to ascertain the elasticity of the muscle. The tension of the reinforcing tendon should be gauged thus:—it should be pulled upon so far and for so long as it shows signs of complete resiliency and no further. In effect, "stretch well and stitch well." For sutures they prefer fine Chinese silk† boiled for half-an-hour and then placed for a week in 1:1,000 potassio-mercuric iodide in spirit. Tendon-transplantation combined with arthrodesis will be dealt with under the heading of arthrodesis (*q.v.*).

After-Treatment.—The foot or limb is placed in the fully corrected position, and therefore in such a way that there is no tension whatever on the reinforcing muscle. It is left thus for six weeks to ensure good union of the tendon. In some cases, on removing the splint or plaster of Paris, it may appear that over-correction has been made, and the reinforcing tendon is so tight as to seem to demand tenotomy. If it has not been over-stretched at the time of operation, no interference is called for, as with free movements of the part the muscle readily adapts itself to the length required. A light retentive apparatus should be employed to assist in keeping the part in its new position. Daily massage and the interrupted current should

* I will take this opportunity of warning my readers against making needless incisions for exploration. These cases, long the subjects of trophic lesions, are not ideal ones for primary union. Further, any incisions required should not be too long; the scars are undoubtedly liable to become keloid, a result which may interfere with the after treatment, and the pressure of boots.

† If any of my readers prefer kangaroo-tail tendon, they will find some difficulty in obtaining it fine enough for the small tendons concerned here. Whatever material is used, the possibility of stitch-sinuses must be remembered. Lange has met with these in 2 per cent. of his cases. Vulpinus, one of the earliest and chief workers at this subject, gives six as the percentage from his last fifty cases.

be assiduously employed. When it is evident that the muscle is undergoing hypertrophy, the support should be dispensed with.

Various Methods of Transplantation.—Messrs. Tubby and R. J. Jones give some thirteen as recognised. They consider the following the most useful.

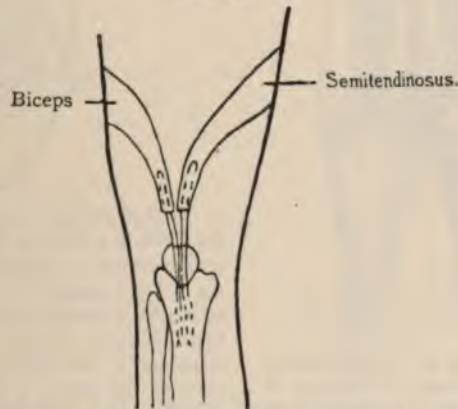
(1.) The paralysed tendon is left undivided. The reinforcing tendon is completely severed, and its proximal end is grafted into the paralysed tendon, the distal end of the reinforcing one being left free.

(2.) A slip is partially detached from the reinforcing tendon; the paralysed tendon is completely divided, and the reinforcing slip is joined to the distal part of the paralysed tendon.

(3.) A slip is partially detached from the reinforcing tendon, and inserted into the paralysed one.

(4.) The method of periosteal implantation promises to be of great value in certain conditions. These are readily recognised at the operation. The tendon of an extensively paralysed muscle is often very lax, and, when pulled upon, stretches unduly, so that, even after being reinforced, it will become slack, and render useless the power of the

FIG. 38.



Länge's method of artificially elongating the transplanted hamstring tendons by silk sutures, so as to effect a junction with the tubercle of the tibia. (Tubby and Jones, after Länge).

reinforcing tendon. Very paralysed tendons are recognised by their dull opaque colour, and their readiness to stretch. When such are found, implantation into the periosteum instead of into the tendon is indicated.

(5.) In some cases, *e.g.*, with the gastrocnemius, it is possible to make a separate muscle and tendon. If a long incision is made in the back of the leg as high as the junction of the two heads of the muscle, the gastrocnemius can be split longitudinally, and a portion of the tendon of the split muscle re-attached in another spot, and used to correct either valgus or varus (Fig. 41, p. 59).

The two next methods refer more particularly to tendon-transplantation about the knee.

(6.) The indirect method. Here a comparatively useless tendon is employed to bridge over the gap between the reinforcing and paralysed tendons. Messrs. Tubby and R. J. Jones have found this indirect method valuable in transferring the biceps to the patella, in order to reinforce a paralysed quadriceps. This above-mentioned tendon is often too short to be brought across the required distance. If the ilio-tibial band be separated at its lower part, the severed biceps tendon can be attached to it, and the conjoined band so formed carried on to the patella.

(7.) The method of making artificial tendons of silk and thus prolonging the reinforcing tendons as practised by Länge (*Munch. Med. Woch.*, April, 1900, Jan. 7th, 1902, and *Med. Record*, vol. v., No. 3, pp. 143—145). Where the distance between the sound and

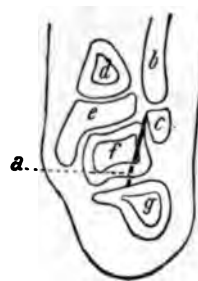
paralysed tendons is great, this surgeon makes artificial tendons of silk (Fig. 38.) He reports fifty-six cases. In all primary union was secured. In only two was the result unsatisfactory. In a case of paralysis of the quadriceps femoris, where attempts to correct the deformity by suture of the sartorius to the quadriceps had failed, Lange brought the semitendinosus and biceps forward under the skin, after freeing them from their insertions. The ends were now found to be so far above the patella that it was impossible to suture them into the tendon. A serviceable silk tendon was provided by the passage of a number of silk threads through the tendinous ends of the transplanted muscles above, and the periosteum of the tubercle of the tibia below, giving eventually excellent power of extension. Several of the artificial tendons were eight inches long. They were very durable. When, some months after the operation, the transplanted muscles began to act, and render the silk cords constantly tight, these steadily increased

FIG. 39.



Tendon-grafting for relief of paralytic talipes calcaneus by insertion of the peroneus longus tendon *a* into the tendo Achillis at *b*. At *c* is seen the distal end of the peroneus longus. (Tubby and Jones.)

FIG. 40.



Vertical section through the bones about the ankle in a child to illustrate a method of counteracting a varoid position in talipes. An oblique section *d* is made through the astragalus *f* and the part of the bone internal to *a* removed; *b* and *c* are the shaft and epiphysis of the fibula; *d* and *e* the similar parts of the tibia; *g* is the os calcis. The oblique line is drawn a little too near to the fibula. To correct permanently talipes valgus the section should be made in the opposite direction. (Tubby and Jones.)*

in thickness. It is probable that the increase in size was due to the formation of fibrous tissue around the silk.

The following are instances of some of the cases in which tendon-transplantation has been successfully employed by Messrs. Tubby and R. J. Jones. Numerous illustrative cases are given, which will well repay perusal.

Paralytic Talipes Calcaneus.—Messrs. Tubby and Jones write thus of this form of talipes (*loc. supra. cit.* p. 83): "Of all simple forms of paralysis talipes calcaneus is that which is best adapted for tendon-transplantation, and admirable results have been obtained by grafting the peroneus longus or part of it into the tendo Achillis at the outer side, and the flexor proprius hallucis or part of it into the inner side." This can be treated by transferring one of the peronei on the outer side, and part or whole of the flexor longus digitorum into the T. Achillis, or better still, into the periosteum of the

* As advised by R. Whitman, removal of the astragalus may be performed instead of the above section, in addition to arthrodesis, tendon-transplantation and shortening of the tendo Achillis, if now needful.

os calcis (Fig. 39). This is especially indicated where the tendo Achillis is so wasted (perhaps after previous operations for tenotomy or shortening) as to be thin and membranous and more like a fascia than a tendon. Opportunity may be taken at the same time to shorten the tendo Achillis and to remove a wedge from the astragalus (Fig. 40). The writers have resorted to this step, because they found that after tendon-transplantation alone for simple calcaneus, the foot assumed a valgoid position on account of the instability of the calcaneo-astragaloid joint. The wedge is taken from the outer side, and is so placed that its base is upwards to prevent valgus, and downwards if it is needful to counteract varus.

Paralytic Talipes Calcaneo-Valgus.—This can be successfully treated by insertion of the peroneus longus into the inner side of the tendo Achillis, and in most instances arthrodesis of the ankle may be advantageously combined. Much attention must be given and

FIG. 41.



Operation for relief of paralytic talipes equino-valgus. The inner part of the gastrocnemius and tendo Achillis is split off at *a*, *a*, and divided at *b*. (Tubby and Jones.)

FIG. 42.



The second stage of the operation for the relief of paralytic talipes equino-valgus. The inner half of the gastrocnemius and tendo Achillis *a* is brought forward and united either to the tibialis posticus *b*, or the periosteum of the scaphoid. The third stage consists in division of the outer half of the tendo Achillis in order to relieve the equinus. (Tubby and Jones.)

several weeks must be first taken in correction of the cavus by division of the plantar fascia and wrenching. In one case, in addition to grafting the peroneus longus into the tendo Achillis, the outer two tendons of the extensor communis were transferred to the tibialis anticus and periosteum of the scaphoid by an incision on the front of the ankle. The power of the extensor was thus secured to raise the inner border of the foot. This was put up in the position of equino-varus, and so kept for six weeks.

Talipes Calcaneo-Varus.—Here the flexor longus digitorum should be inserted into the outer side of the tendo Achillis, and the distal part of the cut flexor united with the flexor hallucis. Here, too, much attention will be needed with the contracted plantar fascia.

Talipes Equino-Valgus (Figs. 41 and 42).—The tendo Achillis and gastrocnemius should be split as far as the junction of the two heads, and then the inner portion of muscle and tendon should be inserted either into the tibialis posticus, or, better, brought well forward and fixed to the under aspect of the scaphoid. This relieves the valgus part of the deformity. The equinus is readily rectified by section of the remaining part of the tendo Achillis. The peronei will require resection, or, better, the peroneus longus should be brought round and inserted into the flexor longus digitorum.

Talipes Valgus (Fig. 43).—The proximal part of the peroneus brevis (divided just above its insertion) should be inserted into the tibialis anticus above the ankle joint, and, if needful, the peroneus longus should be divided or resected. It is necessary to remove a wedge from the outer side of the astragalus, the base of the wedge being upwards (Fig. 40). In slighter cases it is sufficient to graft the outer tendons of the extensor longus digitorum into the tibialis anticus or into the periosteum on the inner side of the foot.

Talipes Varus.—This may be treated by transplanting the tibialis anticus or extensor proprius hallucis into the peroneus brevis above the ankle, and the removal of a wedge from the astragalus, the base of the wedge being downwards; or the wedge may be removed horizontally, the base being outwards (Fig. 40).

Talipes Equino-Varus.—Messrs. Tubby and R. J. Jones recommend splitting the tendo Achillis throughout its whole length and the gastrocnemius as well, thus making a new muscle. Then by dividing the peroneus longus and brevis, and attaching to their distal ends the outer half of the tendo Achillis and gastrocnemius, they have succeeded in replacing the paralysed peronei by the outer half of the healthy gastrocnemius. They have found the result eminently successful.

FIG. 43.



Tendon-transplantation for the relief of paralytic talipes valgus. The peroneus brevis, *a*, is divided and inserted into the tibialis anticus, *c*, at *e*. At *d* is seen the distal end of the peroneus brevis, and *b* marks the peroneus longus. (Tubby and Jones.)

Paralysis of Quadriceps Femoris.—Where this muscle is paralysed and the sartorius escapes, the latter, and with it, if needful, a portion of the biceps and semitendinosus may be transferred to the top of the patella, with the result of rendering the knee rigid in standing and restoring some power of advancing the foot in walking (Figs. 44 and 45). A curved flap of skin and subcutaneous tissue—the objection to this method of which I spoke at p. 55, is less applicable here—with its centre reaching to the top of the patella, having been turned up over the lower third of the thigh, the sartorius is isolated, its insertion is cut through and attached to the quadriceps or top of the patella. A strip of the biceps and semitendinosus can be dealt with in the same way. If needful, the transplanted tendons can be artificially elongated by Lange's method with silk (Fig. 38), or by using the ilio-tibial band, as advised by Messrs. Tubby and R. J. Jones (p. 57).

Vulpinus has met with good results in transplantation of tendons about the knee. Mr. Montgomery, on the other hand (*loc. infr. cit.*) has found this method “most unsatisfactory, the transplanted muscles being never strong enough to control the weight and movements of a heavy limb.”

Infantile Spastic Paralysis, or Cerebral Paralysis of Children.*—The two authors from whom I have quoted above group their cases into (i.) infantile hemiplegia; (ii.) cerebral diplegia; (iii.) spastic paralysis. In cerebral diplegia, while rigidity and paralysis are associated, rigidity is the more striking feature; in the hemiplegic form paralysis preponderates, the rigidity being secondary to it. Again, in the hemiplegic form, the arm is more affected than the leg, but this is not so with the diplegic form.

* Though the lesions of this disease also are chiefly met with in the lower extremities, I have dealt with this subject here for convenience sake. For a full description of the deformities due to this hitherto most unpromising disease, my readers are referred to Messrs. Tubby and R. J. Jones's “Surgery and Paralysis,” p. 197, from which this account is taken.

The following facts are of chief interest to the surgeon :—(a) *The upper limb*, when affected, is more affected than the lower. (b) The lesion of the upper limb is more permanent. (c) The power of dorsi-flexion of the hand and the simultaneous extension of the fingers is lost. (d) The movements are performed without precision, spasmodically and slowly. (e) The power of the thumb is often lost.

The disabilities of the lower limb are generally (a) Contraction of the knee. (b) Extension of the foot. (c) Internal rotation of the femur, with adduction. (d) Rigidity.

The cerebral diplegic form is by far the most serious, as we have to deal here with both arms and legs. Clinically this group may be divided into (a) Cases with and without severe mental complications. (b) Complete and partial disability of the hands. (c) Complete and partial disability of the limbs. (d) Cases associated with athetotic movements.

A. *The classes of cases which are and are not adapted to treatment.*—"A suitable case for treatment is a child or young adult of fair intellectual development, who has had no fits for three or four years. Such a case may be brought with the following conditions :—The feet are in a state of talipes equinus or equino-varus. The knees are flexed owing to the tightly contracted hamstrings, and they knock together on account of the adduction of the thighs. The thighs are flexed and inverted, and the tensor fasciæ femoris, sartorius and ilio-tibial band are rigidly contracted.

B. *The classes of cases which are entirely unsuited for treatment* are the idiotic, the microcephalic and the violently irritable diplegic who is subject to fits, active athetotic movements and convulsions, and the patient who has no control over the excretions. Another class of case which gives much anxiety and trouble is that where the affection of the hands is of such kind as to promise but slight hope of their assistance to the limbs during walking ; that is to say, if the paralysis is complete, or if spasm of the hand and arm never relaxes, treatment, in the writers' experience, is of little avail. If the fingers of the affected hand are only moved in conjunction with the fingers of the opposite side the results in all probability will be discouraging. If, however, it can be ascertained that the patient is able to do more with the hand than a little time ago, the success of treatment is probable. Similarly, where any degree of voluntary relaxation exists, apart from an associated movement on the opposite side, treatment is the more urgently called for. It is important to recognise the length of treatment required. Active treatment may be required for two years, and it is therefore unwise to undertake a case in the hospital for two months and then to send it to a miserable home, where neglect will be the inevitable consequence. The co-operation of intelligent parents must be secured, anxious to do all they can for their child and willing to face all the trouble involved in careful training."

The principles upon which Messrs. Tubby and R. J. Jones advise operation are these :—(1.) A constantly overstretched muscle tends to continued weakness and degeneration. It is only by being placed in a state of rest by division that it can recover. (2.) As excessive deep reflexes are characteristic of this disease, the important point is, if possible, to limit this excitement. Now if the tendon of a tightly contracted muscle is divided, the stimuli which it sends to the cord, and which are thence reflected to the muscles, abate. Thus, by division of the tendo Achillis, the pointed condition of the foot and the constant pull on the parietic extensors is remedied by giving these latter muscles rest and time for recovery. Again, by division of the tendo Achillis, the reflex excitability of the calf muscles has been largely abolished ; and not only so, but the authors believe that the removal of this excessive reflex excitability of the cord permits of that quiescence of the nerve centres so essential to the welfare of these children.

FIG. 44.



Transplantation of the sartorius into the patella at *a* to reinforce a paralysed quadriceps. The distal part of the divided sartorius is seen at *b*. (Tubby and Jones.)

Treatment.—This falls into the following divisions:—(A.) *Operative* and (B.) *post-operative*. (I.) *Treatment of the Upper Extremities*. (II.) *Treatment of the Lower Extremities*.

I. *Treatment of the Upper Extremities.*—The most pronounced deformities here are pronation and flexion of the wrist, so that treatment should consist in rendering the forearm supine and in hyperextending the wrist. The operative steps will include tenotomy, tendon transplantation and lengthening of tendons. In the two latter

especially, treatment will necessarily be very prolonged, as about the wrist so many tendons have to be grafted and lengthened, while there is considerable risk of matting of the tendons when several of them must be sutured, and the amount of suture material employed is great (p. 65). Two especial operations are described by Messrs. R. J. Jones and Tubby. One the converting the pronator radii teres into a supinator by transplanting its tendon behind the radius, through a hole in the interosseous membrane, to the outer side of the radius. This operation will be found described by Mr. Tubby in the *British Medical Journal*, Sept. 7, 1901. The other operation is converting by transplantation the flexor carpi radialis and ulnaris into extensors, and in reducing the carpal flexion.

Dr. Gray, surgeon Royal Aberdeen Infirmary, recommends (*Lancet*, May 21, 1904, p. 1419) that transplantation of the flexors of the carpus on to the dorsum should replace the necessity of turning the pronator radii teres into a supinator, a step which largely diminishes the power of pronation. He made use of the former method in a case of musculo-spiral paralysis. The following account illustrates the steps employed:—

The case was one of musculo-spiral paralysis from inclusion of the nerve by callus in a fracture of the right humerus. Operation had failed, and the patient, a lad of sixteen, came under Dr. Gray's care with complete musculo-spiral paralysis. Fingers and wrist were flexed, there was complete loss of power of extension at the metacarpo-phalangeal articulations, and of supination when pronation was complete. The biceps retained some power as a supinator. The flexors and pronators were normal. The flexor C. ulnaris tendon was exposed by a longitudinal incision and divided just above the pisiform bone. An oblique incision was next made over the back of the forearm reaching to the level of the wrist-joint, the extensors turned aside, and a tunnel made close to the ulna through the interosseous membrane just above the upper border of the pronator quadratus. A forceps was passed through this from before backwards, and the tendon of the flexor C. ulnaris pulled through. The fingers and wrist

Muscle-transplantation for the relief of paralysed quadriceps by reinforcement of the paralysed muscle from the biceps and sartorius. At *a* a slip is brought forward from the biceps; at *b* the proximal part of the sartorius is brought forward and the muscular slips *a* and *b* are inserted into the patella at *c*. The distal portions of the biceps and sartorius are shown at *d* and *e*. If the sartorius be paralysed, the semitendinosus may be used instead. (Tubby and Jones.)

were then hyperextended, the extensor communis tendons cut through just above the wrist-joint and their distal ends sutured to the end of the flexor C. ulnaris. Over the dressings plaster of Paris was employed, the fingers and wrist being kept hyperextended and the elbow flexed. At the end of three weeks, when the plaster of Paris was removed, the wound was soundly healed. The fingers were now flexed, and the lad told to straighten them; he did so at once, and to the full extent. Supination was also possible with the limb in full pronation. The thumb remained more or less flexed into the palm. Mr. Gray desired to use the flexor C. radialis to produce extension of the thumb, drawing it through the interosseous space close to the radius and then attaching to it the severed tendons of the extensors of the thumb at different levels. On a similar occasion he would transplant

FIG. 45.



both flexors of the wrist at one sitting, in order to bring about extension of fingers and thumb and supination. In his case the patient was so pleased with the result that he was not inclined to submit to any further operation.

After-treatment movements should be, at first, about two weeks after the operation, gentle and gradual, but after six weeks should be vigorously practised. The principles which should guide them are thus indicated—(a) The movements should be practised slowly without excitement. (b) They should be made interesting to the patient. (c) Those movements which are opposed to the direction of deformity should predominate. (d) Those presenting the greatest difficulty should be chiefly practised.

(2) *Treatment of the Lower Extremities.*—The following series of operations on the hip, knee, and ankle are required, and performed if necessary, in stages. Open operation is always indicated. The adductors of the femur are first dealt with. The adductor longus is freed by a longitudinal incision, and three quarters of an inch of its tendon removed. The limb is abducted and the adductor brevis and the gracilis are treated in the same way. If needful, the horizontal part of the adductor magnus and the pectineus are divided, in fact, every tissue which limits free abduction, the sartorius, tensor fasciæ femoris and ilio-tibial band are attacked in the same way. The knee is then dealt with by longitudinal incisions, one on either side usually sufficing. By burrowing under the subcutaneous tissue, and retracting the skin, the various bands of fascia can be reached and divided as well as the hamstrings. A portion of the hamstrings is removed, if needful, an operation practised by Mr. R. J. Jones, as long ago as 1885. The tendo Achillis is then elongated by the L method, and the patient is stretched comfortably upon an abduction frame, or a simpler arrangement of two Thomas knee-calliper-splints, with the lower extremities fully abducted, the knees straight, and the feet at right angles. At the end of three months, the splint is taken off during the day, and movements are sedulously practised. A little later, when the patient has been taught to stand unsupported, walking is begun with crutches and somewhat similar splints fitted below into boots with stout soles. At first, the nurse must be careful that the limbs are not approximated. The limbs must be kept abducted at night, and massage of the muscles, with active and passive movements of the different joints and adduction of the limbs must be assiduously practised. The aim should be to secure power of walking with one stick only and without other artificial aids. The patient must be under the surgeon's control for at least twelve months. If this and the intelligent co-operation of the parents be secured, "the child should be able to walk distances aided by sticks in from twelve to twenty-four months, and this with perfectly straight limbs, and toes and heels on the ground. Later on, many cases will manage to walk with one stick only, and others will dispense with all kinds of artificial aids."

I have given Messrs. Tubby and Jones' conclusions at length because of the pains which they have taken to develop the different operations and the authority with which they speak upon orthopædic subjects. But it is right to state that there is another side to this question, and that other opinions are far less favourable. In this country neither Mr. Keetley nor Mr. Jackson Clarke speak highly of the results in their books on Orthopædic Surgery. And it must be remembered that both are men of large experience and well-known fairness.

From America, where every fresh operation is at once tested largely and with much zest, we have warnings not to expect too much from tendon-transplantation in infantile paralysis.

Thus Dr. Royal Whitman, a well known authority, speaking at a meeting of the New York Academy of Medicine (*Med. News*, April 12, 1902) said: "In reporting cases it is usually affirmed that the results after a long period will represent a continuance of the improvement to be noted two or three months after the operation, but this is not always true. As a matter of fact, the primary over-correction after operation usually sets opposing forces at rest for some time. This gives rise to hope when the patient is first relieved of his dressings, and the transplanted muscles perform their first actions. After a while the over-correction fails, and the result is then often very disappointing."

Dr. Hibbs, speaking at the same meeting from an experience of 150 cases operated on at the New York Orthopædic Hospital, spoke more strongly still. "Where sufficient time is allowed to elapse, the ultimate compared with the immediate results are a rule very disappointing. In itself tendon-transplantation practically never fulfils expectation, and is only a help to the use of apparatus. It is not an independent orthopædic measure; it does not prevent deformity, but may be used as an adjunct to facilitate the use of apparatus, and thus enable the orthopædic surgeon to use any possible bit of force which the patient can exert. The operation undoubtedly deserves a place in the armamentarium of the orthopædic surgeon, but has nothing like the marvellous effect which is sometimes claimed for it."

Mr. Montgomery, of the Children's Hospital at Pendlebury (*Med. Chron.*, April, 1905, p. 37), after speaking guardedly of the results attained, sums up in words with which most will agree: "The more complex, the more indirect, the more ingenious the method, the worse the result; the directer, the simpler, the more obvious, the better."

I have endeavoured to put both sides before my readers. All will allow that the results of treatment of infantile paralysis are, like those of lupus, amongst the least creditable to us. If tendon-transplantation does no more it may at least do good by attracting, with its glamour of a new operation, more attention to a greatly neglected subject. Whether the results claimed by some are verified in the future depends not so much on perfection of technique—already largely arrived at—as on a wise selection of cases, more careful attention to after-treatment, in which the patient and friends must share a larger responsibility, and, above all, to general practitioners ceasing to look upon these cases as ones in which nothing can be done and allowing them to drift on until, early childhood past, the mischief is advanced and confirmed, and not only the tendons—to which too much attention has been directed—but the ligaments, joints, bones, fasciæ, and skin are all concerned. Finally the literature of this subject, which is increasing so rapidly,* would gain greatly in value if those reporting cases of operation would do so in more detail and with greater accuracy, and, also, would give us the later as well as the earlier results, telling us especially how far tendon-transplantation does away with that worst of all sequelæ of infantile paralysis, viz., the trophic ulceration which is so liable to set in in late adolescence and early adult life, and call for amputation of the thigh.

Ischæmic Paralysis.—This term, given to the condition of fixed contraction affecting usually the flexors of the wrist and hand, and most frequently due to injudiciously applied splints, has not received from most writers the attention it merits. As its occurrence is not very rare, as it cripples one upper extremity in a young subject, and as, thanks to modern surgery, we are now in a position to greatly obviate the deformity by tendon-lengthening, I have dealt with the subject here. Helpful papers have been written by Mr. H. Page (*Lan.*, Jan. 13th, 1900, p. 83), Mr. Littlewood (*Lan.* i. 1900, p. 291), and Mr. Barnard (*Lan.* i. 1901, p. 1138). While the pathology of all the cases is not as yet clear, it is certain that this crippling deformity may follow pressure on muscles, pressure on the blood-supply, interference with the nerve-supply, the use of Esmarch's bandage, exposure

* Vulpius, of Heidelberg, published in 1902 a monograph which contains a list of about 200 papers on the subject.

to long-continued and severe cold, and rupture or severe contusion of muscles—*e.g.*, the flexors of the forearm. In the cases usually met with, where splint-pressure has been the exciting cause, a hyperplasia of the connective tissue of the muscles is probably set up, gradually passing into fibrous tissue and bringing about contraction, interference with the blood-supply, and, thus, the deformity in about four to six weeks after the injury. While sloughing of the skin, especially that over the bend of the elbow, is not uncommon, the deformity may develop without any such warning.

Mr. Barnard has reported two cases very fully. Abstracts of them are given here.

In the first, the patient, æt. 13, had been treated for a fracture of both bones of the right forearm. The day after the fracture there was no pain. When the splints were readjusted at the end of a week, a pressure-sore was found on the front of the forearm. A month later, the fingers began to be flexed, and, six weeks after the fracture, the hand was in the position of *main en griffe*. There was no definite anaesthesia, but voluntary movements were lost in the hand and wrist. Operative interference was delayed by the healing of the pressure-sore, and a whitlow on the tip of the right index-finger. Six months after the injury, an incision was made along the forearm, skin-flaps were reflected, and the tendons, no thicker than stout twine, split for one and a half inches and the halves severed above and below, on opposite sides (Fig. 31, p. 47). The fingers were then extended, and the two halves of the divided tendons allowed to slide upon each other as much as was necessary, and then united with one or two sutures of No. 1 or 2 silk. The tendons of the flexor profundus digitorum were so blended and adherent in the depths of the wound that there seemed no end to the tiny strips which were separated from the mass and divided until all the terminal phalanges could be extended. Confusion was prevented by employing guide-sutures. The deepest tendons were sutured first. No form of tourniquet was employed; the whole operation, which lasted two hours, was strangely bloodless. The muscles, where exposed, were pale, firm, dry, and fibrous. The limb was put up on a back-splint with the fingers fully extended. Healing took place by first intention. A fortnight after the operation, massage and passive movements were begun. The sound arm was tied up, and plenty of toys given to the patient.

The second case was a boy æt. 4, whose forearm had been severely crushed with much effusion of blood, but without fracture. The limb was placed on an external angular splint, and light bandaging employed. Five weeks later the trouble began to appear, and, eighteen weeks after the accident, the hand was in the position of typical *main en griffe*, the forearm being fully pronated and flexed. There was no definite anaesthesia. At the operation there was the same absence of hæmorrhage as in the first case. When, after one and a half hours of tedious work on tiny tendons, Mr. Barnard saw the mass of ragged ends and knotted silk, the prognosis appeared so hopeless that he did not interfere with the pronators. The wound healed by first intention, and it soon became clear that the tendons had united beyond expectation. The tendon of the deep flexor to the index and second fingers did not act for some weeks, this being explained by the fact that it was not elongated enough and had to be united end to end. Improvement after four months was so marked that the mother wished something done for the loss of rotation of the forearm. The insertion of the pronator radii teres was exposed and the radial vessels and nerve separated from it. The muscle was then split and divided on opposite sides as the flexor tendons had been. As supination was still imperfect, an incision was made over the lowest part of the ulna, between the extensor and flexor carpi ulnaris. The pronator quadratus was separated with a periosteal elevator from the ulna. The pronator radii teres was then sutured in the upper part of the wound. The forearm could now be fully supinated on a splint.

Five to eight months after the operation both children could grasp a stick or pick up a pin; neither could make a fist, but both cases were steadily improving. In Mr. Page's case, improvement was not well marked until ten months after the operation.

CHAPTER II.

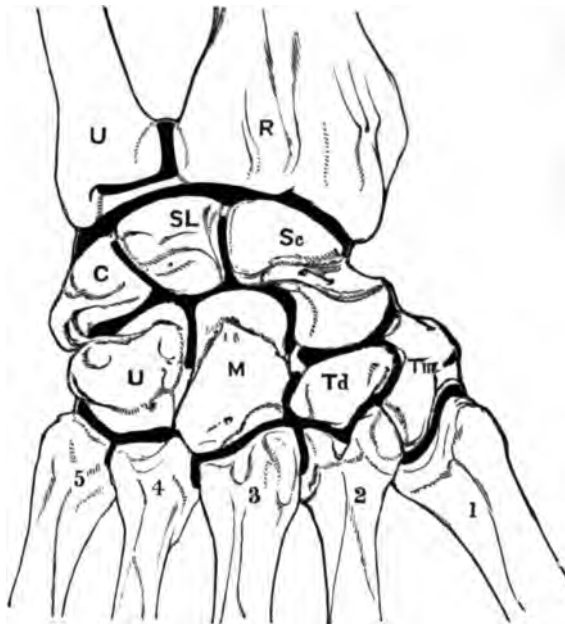
OPERATIONS ON THE WRIST.

EXCISION OF THE WRIST-JOINT (Figs. 46 to 49).

THE reasons for this operation often failing, and the conditions needful for success, may be first considered.

I. Whether the tubercular disease begins in the synovial membrane or in the bones, it extends rapidly, not only to the wrist-joint, but to

FIG. 46.



The bones and the seven synovial sacs which enter into joints about the wrist. The seventh, that between the cuneiform and pisiform, is not shown. (MacCormac.)

the two rows of carpal bones and the bases of the metacarpals, along the complicated synovial membranes,* which bring all these bones into

* The arrangement of these, five in number, must be remembered, and their close vicinity to each other. (1) The membrana sacciformis of the inferior radio-ulnar articulation, passing from the lower end of the ulna to the sigmoid cavity of the radius,

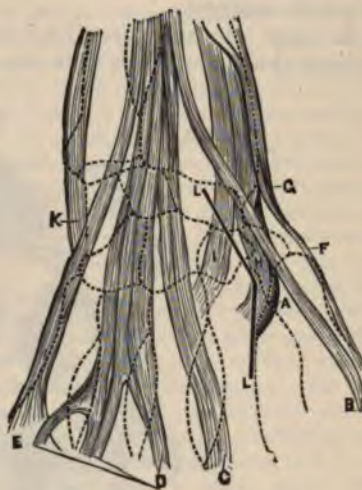
contiguity with each other. The disease, thus extensive, is also most obstinate, and is often further complicated by other tubercular lesions, and, in adults especially, by a tendency to phthisis. Thus partial operations are useless, and often worse than useless. Lord Lister* was the first to insist on the importance, and to show the possibility, of removing every atom of the disease, including the ends of the radius and ulna, the two rows of carpal bones, and the bases of the metacarpals (Fig. 48).

2. From the close relation of the flexor and extensor tendons in front and behind these complicated joints, and from the numerous grooves on the bones, it is most difficult to extirpate the disease without disturbing the tendons. On the other hand, however stiff the wrist may be left, flexion and extension of the fingers is absolutely needful for the operation to be a success; hence it is imperative that, throughout the prolonged operation, the tendons should be disturbed as little as possible, a direction very difficult to follow, as their cellular sheaths are often tubercular, and the necessary manipulations of the tendons during the operation may easily lead to their sloughing, and thus to a useless "fin-like" hand.†

3. Passive movement of the fingers should be begun as early as possible, and most perseveringly maintained (p. 75).

Owing to the unsatisfactory character which this operation inherited by the very poor results to which it attained before the days of aseptic and antiseptic surgery,

FIG. 47.



A, Radial artery. B, Extensor secundi internodii pollicis. C, Extensor indicis. D, Extensor communis. E, Extensor minimi digiti. F, Extensor primi internodii. G, Extensor ossis metacarpi. H, Extensor carpi radialis longior. I, Extensor carpi radialis brevior. K, Extensor carpi ulnaris. L L, Line of radial incision. (Lister.)

and lining the upper surface of the triangular fibro-cartilage. (2) That of the wrist-joint proper, passing from the lower end of the radius and the inter-articular fibro-cartilage above to the bones of the first row below. (3) The common synovial membrane of the carpus, the most extensive of all, passing from the lower surface of the scaphoid, semilunar, and cuneiform above to the upper surface of the bones of the second row, sending up two prolongations between the scaphoid and semilunar and the semilunar and cuneiform, and also sending downwards three processes between the four bones of the second row, prolonged down into the carpo-metacarpal joints of the four inner metacarpal bones. (4) A separate one between the cuneiform and pisiform. (5) Another separate one between the trapezium and metacarpal bone of the thumb. A variety of the above arrangement in which seven synovial sacs are present is shown in Fig. 46.

* *Lancet*, 1865, vol. i. p. 308. From this paper Figs. 47 and 48 and the steps of the operation are taken.

† Sir J. E. Erichsen (*Surg.*, vol. ii. p. 383) wrote thus of this point: "If we look at the tendons which surround the wrist, we shall find them divisible into five groups—

owing to the unsatisfactory conditions, both general and local, with which the surgeon is called upon to deal—the established tubercular trouble, often not isolated in the wrist-joint, the joint itself and tendons, it may be, riddled with sinuses, and the fingers swollen and stiff;—owing to the complicated and difficult operation required; and, lastly, owing to the impossibility of practising to any really helpful extent this operation on the dead body: for the foregoing reasons excision of the wrist has not found the favour with English surgeons which it deserves.

In spite of the above disadvantages and difficulties it is much to be desired that, as no less than the saving of hand and fingers is at stake,

FIG. 48.



Parts removed in excision of the wrist. (Lister.)

this operation should, with the advantages of modern surgery, be persevered with, and that all cases, whatever the result, be fully published.

I have described two methods only. Excision of the wrist is not a common operation; it must be a difficult one; and the operating surgeon will do well to make himself familiar with, and to practise, one method. The two methods given below bear the names of surgeons who are authorities on the subject—(1) Lord Lister's, introduced to the profession as long ago as 1865; (2) that of the late M. Ollier, the well-known surgeon of Lyons, whose name stands second to none as an authority on excision of joints, and who has done more than any other surgeon to place excision of the wrist on a sound basis. I recommend the second method as the less complicated of the two, having used it in

(1) Those special to the thumb; (2) The extensors of the fingers; (3) The flexors of the fingers; (4 and 5) The flexors and extensors of the wrist. Now, the incisions should be so planned as to save absolutely the whole of the first three groups and to divide only the tendons of the wrist proper, and these are cut so close to their insertions that, as a rule, they form new attachments, and resume their functions as recovery takes place." I have referred to the question of how far division of any tendons is necessary, below (footnote, pp. 70 and 71).

three cases. In young children, owing to the weakness of the ligamentous and other fibrous single structures, the single longitudinal dorsal incision of van Langenbeck or Boeckel—for they are practically the same—may suffice.*

(1) **Lord Lister's Operation** (Figs. 47, 48).—An anæsthetic having been given, and the parts rendered bloodless by an Esmarch's bandage,† any adhesions of the tendons are thoroughly broken down. The hand should rest on a sand-pillow. The surgeon should be seated. The radial incision is then made, as in Fig. 47. This incision is planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed towards the inner side of the metacarpophalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little further out. These directions will be found to serve, however much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by the thumb-nail, and raised, together with that of the extensor brevis, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting forceps applied in a line with the longitudinal part of the incision, great care being taken of the radial artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected out without much difficulty, whereas its intimate relations with the artery and neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering the knife at least two inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect. The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger

* My old friend G. A. Wright, of Manchester, has made use of a similar incision (*Abstract of Med. and Surg. Cases treated at the Pendlebury Hospital*, 1884, p. 133). In a child of 9, with phlyctenular ophthalmia, enlarged glands, and many marks of "strumous" disease, the right wrist was disorganised. "A single longitudinal incision for three or four inches was made between extensor communis and extensor secundi, the carpal joints opened, and the bones easily shelled out; the ends of the metacarpal bones and of the radius and ulna were removed with a gouge; one vessel was twisted; no tendon was divided, except in the sense of turning back the extensors of the carpus from their attachments. Six months later, the hand, which before the operation was bulbous, flabby, and useless, was all but healed, and had well shrunk; there was excellent power and mobility." In 1877 I removed five of the carpal bones by a single dorsal incision in an infant, aged $2\frac{1}{2}$ years, a patient of Dr. T. Eastes, of Folkestone, the sinuses present being thoroughly scraped out with a sharp spoon. The result was most satisfactory, both as to the permanency of the cure and the usefulness of the fingers.

† Sir F. Treves objects to this step, as the oozing which follows the removal of the bandage is usually very considerable and, in his opinion, a great obstacle to healing. I have advised the use of the bandage because, at the time, it is most important not to have the field of the wound constantly flooded by the small vessels of the very vascular parts, this hæmorrhage imperilling the tendons, rendering the operation still more tedious by its interference with the exact carrying out of every detail which is so essential whichever method is selected. Any harm which may accrue from excessive oozing may, I think, be met, as after excision of the knee, by providing adequate drainage, using very few sutures, and enveloping the field of the wound in very ample dressings, through which the discharges shall be uniformly distributed.

extensors are then separated from the carpus, and the dorsal and internal lateral ligaments of the wrist-joint divided, but the connections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pisiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones, for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist-joint is also divided, after which the junction between carpus and metacarpus is severed with cutting pliers, and the carpus is extracted from the ulnar incision with sequester-forceps, any ligamentous connections being touched with the knife. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh osseous deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundus internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with forceps applied longitudinally.

If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.*

The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of its metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

Lastly, the articular surface of the pisiform is clipped off, the rest being left if sound as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But if there is any suspicion as to its soundness, it should be dissected out altogether; and the same rule applies to the process of the unciform.

The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes.† Only one or two small vessels require ligature. Free drainage must be given. The hand and forearm are put up on

* As an instance of what may be taken away, in one case Lord Lister not only removed the base of the third metacarpal bone, but drilled its shaft into a hollow tube, a sound and most useful hand being retained.

† If any of the tendons are unavoidably so interfered with that a portion is likely to slough, it would be well to cut out this part, and unite the ends with a sterilised silk suture. And where much manipulation of a tendon is unavoidable, it would be better to divide it, and unite it subsequently.

the well-known splint of Lord Lister, with the cork support for the hand, which helps to secure the principal object in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the full extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down the adhesions at the time of the operation (p. 69) is maintained.

Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the forearm to the knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the forearm.*

(2) **M. Ollier's Operation**† (Fig. 49) (*Traité des Résections*, 1888, t. ii. p. 448).—No surgeon speaks with greater weight on excision of the wrist than the late celebrated surgeon of Lyons: none have had so much operative experience, and no one worked so hard in order to bring the operation into better favour, and to insist on the necessity of attention to minuteness of detail both during the performance of the operation and in the after-treatment. Finally, M. Ollier not only had unrivalled experience in the excision of this joint, but he has repeatedly, either himself or by his pupils, placed his results before the profession.‡

M. Ollier, having tried several different incisions, recommends the following. At first sight the number (three) appears complicated, but it will be remembered that the third—that over the radial styloid process—is merely for drainage. Following the tendency, with the surgery of the present day, to simplify as much as possible what must in any case be a very complicated operation, I have in three cases made use of a single incision, the chief or metacarpo-radio-dorsal one of M. Ollier. From respect and in justice to that excellent French surgeon, I have given his operation in detail. Much of it refers to advanced cases of disease. It should be the object of all concerned to antedate this stage.

The parts having been made evascular by elevation and an Esmarch's bandage, and all adhesions broken down, the hand is supported, extended and pronated, by a sand-pillow.

* Later on, when this is discarded, if the hand remains weak, I have found it useful to give support on a smaller scale by means of a leather wristlet.

† M. Ollier claimed that by his method, which must be, as far as possible, subperiosteal (p. 74), not one attachment of the tendons need be lost. By other methods the attachments of the extensors of the carpus, those of the flexor carpi ulnaris and radialis, and perhaps that of the supinator longus, are, he maintains, usually sacrificed.

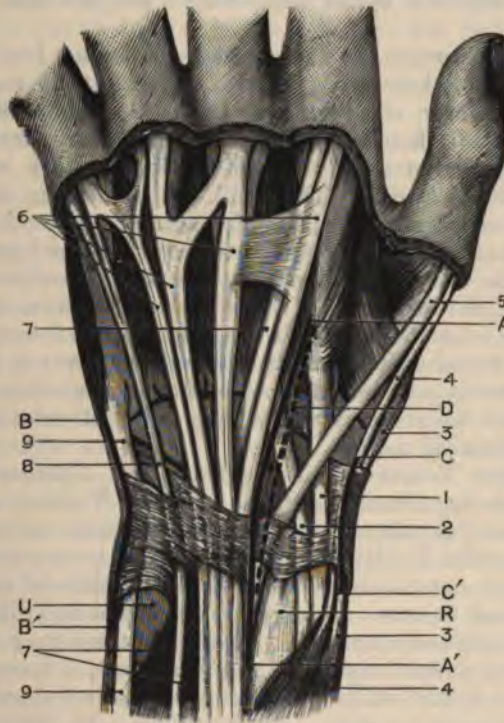
‡ M. Ollier himself, *loc. supra cit.*; *Congrès Franç. de Chir.*, 1894, p. 872; and *Résections des grandes Articulations*, 1895. M. Gangolphe, "Tumeur blanche du Poignet," *Tr. de Chir.*, Dentu et Delbet, 1896, t. iii. p. 595; Dr. Mondan, "La Tuberculose du Poignet," *Rev. de Chir.*, 1896, p. 186.

First Stage : Incision of Skin and Ligaments.—The surgeon, comfortably seated, makes the first and chief incision, metacarpo-radio-dorsal, starting from a point in the centre of a line drawn between the two styloid processes, and running downwards, at first vertically and then somewhat obliquely outwards along the outer side of the extensor indicis, and ending below over the second metacarpal bone at the junction of its upper two and lower thirds. A subcutaneous branch of the radial nerve having been, if possible, avoided, the incision is carried down to the periosteum and dorsal ligaments, great care being taken not to injure the extensor indicis and the extensor carpi radialis brevior. The extensor indicis is first recognised, but its sheath should not be opened as the incision is deepened. It should be drawn aside with a blunt hook so as to expose the tendon of the extensor carpi radialis brevior, the insertion of which it conceals. The periosteum over the base of the third metacarpal is next incised so as to admit of the detachment of the last-mentioned extensor, together with its periosteal sheath, which constitute the radial lip of the deeper part of the wound. The incision is then prolonged upwards along the forearm according to the amount of bone to be removed, and over the annular ligament outside the partition common to the extensor indicis and communis. A little higher up the incision passes between the extensor indicis and the extensor secundi internodii, these tendons being drawn respectively inwards and outwards. In the highest part of the incision the periosteum over the lower end of the radius should be divided. This incision should be four inches or more in length, so as to avoid needless bruising of the soft parts, and to give adequate access to the disease. The ulnar incision is next made, starting about one inch above the styloid process of the ulna, and ending below over the base of the fifth metacarpal bone, the incision being kept rather towards the palmar surface so as to leave the tendon of the extensor carpi ulnaris above in the dorsal lip of the wound. The incision should be made carefully so as not to injure a filament of the ulnar nerve which crosses it, and thus not compromise the sensibility of the little finger. The incision is deepened down to the cuneiform and unciform. A third incision, for drainage only, is made about an inch long over the styloid process of the radius. It should be made now, before the landmarks have disappeared.

Second Stage : Removal of the Bones.—This is facilitated by division of the posterior annular ligament, which allows of easy separation of the tendons. The radio-carpal joint having been opened, the periosteal and ligamentous connections of the carpus are gradually divided, and, the carpus having been made to project more and more above, the flexor tendons are safely detached and held aside in front. It does not matter which of the carpal bones is taken first, whether those that lie beneath the radio-dorsal or the ulnar incisions; as soon as one is removed the extraction of the others becomes easier. The great aim of the surgeon is to remove each diseased bone completely. Being very friable they are easily crushed, and any diseased part that is left adherent is liable to cause a focus of infection and tedious suppuration. Each bone should be turned out of its periosteal and ligamentous adhesions with such a periosteal elevator as that shown in Fig. 66, or with blunt-pointed scissors, or gently seized with small forceps and any

adhesions carefully divided. The pisiform usually, and often the trapezium,* may be left, and the unciform process of the unciform, if sound. Otherwise, if difficulty be met with in shelling out this bone, the process may be cut through, the bone itself turned out, and the process subsequently taken away. The lower ends of the radius and ulna are now examined, each from the incision over them, and dealt with according to the amount of disease present. Thus in some cases

FIG. 49.



The tendons concerned in excision of the wrist.

A A', B B', C C', The three incisions usually employed by M. Ollier. D, The incision of Boeckel, sometimes described as Langenbeck's, the two being practically identical. R, Radius. U, Ulna. 1 and 2, Radial extensors of the carpus. 3, Extensor ossis metacarpi pollicis. 4, Extensor primi internodii. 5, Extensor secundi internodii. 6, Extensor communis. 7, Extensor indicis. 8, Extensor minimi digiti. 9, Extensor carpi ulnaris. (Ollier.)

erosion with a sharp spoon or gouge may be sufficient. In others the ends may be removed by M. Ollier's method of "modelling resection," a small saw being so used as to form a new articular end. The styloid processes should always be left, if possible; and even when all the articular cavity of the radius must go, some of the expanded end of the

* If the trapezium require removal, the flexor carpi radialis must be remembered

ity of the radial artery and

bone should be left so as to furnish a solid support for the hand. The periosteum all round each bone, and lateral ligaments, should be carefully retained when healthy. In young subjects the operator must be careful not to leave a caseating sequestrum in the epiphysial line above a section of bone which is apparently healthy. The same remarks apply to the treatment of the four inner metacarpals, which alone are usually diseased. The bases of any of these which require removal must be most carefully shelled out of their fibrous coverings, or the tendons and the deep palmar arch may be damaged. If more than gouging is required, the section is better made with a fine saw than with cutting forceps.

Question of Preserving the Periosteum.—This step has been objected to on account of its increasing the risk of leaving tuberculous mischief behind. M. Ollier strongly advocates the subperiosteal method. Though riddled with fistulæ and infiltrated with tuberculous granulation-tissue, the periosteum should be preserved, as much as is possible, after thorough curetting. This will aid in making the connection between the metacarpus and the forearm strong and not flail-like, while it will also help in the preservation of the carpal tendons. Prof. Ollier meets the above objection by a thorough use of the curette until only the actual fibrous tissue of the capsule, ligaments, and periosteum is left. If the consistency of this fibrous tissue is found to be altered in places, the actual cautery or the solid silver nitrate is trusted to.

The operation is a tedious and difficult one, requiring the minutest care throughout to avoid injury to important structures, and to get away all the diseased tissues.

Third Stage: Toilette, Cauterisation, and Drainage.—M. Ollier attaches great importance to these points. *Toilette.*—The tendons usually lie buried in tuberculous granulation-tissue extending upwards and downwards to a varying degree. Every infected tendon-sheath must be slit up, and the tuberculous material followed into every nook with scissors and curette. Each tendon must be individually drawn up with a blunt hook and inspected. To render the deeper ones accessible they should be pushed up from the palm, and, if it be needful to get directly at the flexor tendons, one or two incisions should be carefully made in the palmar surface. *Cauterisation.*—M. Ollier advises the use of the actual cautery to the most affected spots, with the view (1) of helping to eradicate the disease; (2) to prevent hæmorrhage; and (3) to obviate the risk of tuberculous infection from the wound (M. Verneuil's "surgical auto-inoculation"). *Drainage.*—Drains of gauze should be freely employed between the different incisions, not only to prevent collections of fluid, but to keep the incisions open for future curetting. The dressings should be voluminous and firmly applied, so as to distribute the free oozing through a large amount of safe material. The Esmarch's bandage, which should have been put on high up in the forearm so as to admit of the application of the above-mentioned dressings, is then removed, and the limb put on the splint which bears Lord Lister's name, an anterior wooden one with a block of cork over which the fingers can be easily flexed, while the wrist is kept extended. Another very efficient splint which can be more readily sterilised is one recommended by Mr. R. Jones, of Liverpool, well known for his contributions to the surgery of the joints. It consists of a simple

anterior bar of sheet iron with two $\perp$ -shaped extremities. These are bent round and grasp the limb just below the elbow-joint above and just above the metacarpo-phalangeal joints below. The part on which the hand rests should be bent at an angle of about 40° so that the hand be kept extended. "If anyone wishes to grip powerfully the wrist is first instinctively extended. One cannot effectively grip with the hand in the flexed position." The first dressing should be left on, if possible, for eight or ten days. If needful the incisions must be kept open with drains for three or four weeks, that any suspicious granulation tissue may be repeatedly attacked with the sharp spoon, &c. Fifteen or twenty days after the operation the period of frequent dressings should begin for the purpose of repeated cauterisations. English surgeons will probably substitute for these the use of sharp spoons and free slitting up of any sinuses.*

After-Treatment.—This must be begun a day or two after the operation, and persevered with for six or nine months, the patient lending an untiring aid throughout the whole of this time. A day or two after the operation the finger-joints should be moved daily, care being taken not to disturb the wounds, and special care should be given to the metacarpo-phalangeal joints, which are liable to escape attention. Moreover, the thumb and index finger must be kept well apart. About eight or ten days after the operation, or as soon as the parts are sufficiently solid, careful movement of the wrist may be begun. Carrying dumb-bells of increasing weight, writing, piano-playing, and the like, are useful exercises. There is a persistent tendency for the tendons to remain adherent in their sheaths, only to be overcome by persevering, assiduous movements, and the use of nitrous oxide gas from time to time. Galvanism, faradism, friction, massage, are all of service when the wound is healed. If the surgeon wish for a good result in the case of hospital patients, he will not allow them to leave too early. As M. Ollier points out, and as his cases show, in addition to excellent movements of the fingers, extension and flexion, abduction and adduction of the hand on the carpus should be very largely recovered by long-continued perseverance. Extension of the fingers and wrist is more slowly regained than flexion, owing to atrophy of the dorsal muscles and matting of their tendons.† Even if the other fingers are

* The above remarks refer only to cases of advanced tubercular disease. When excision is performed early before the stage of sinuses, &c., as should always be the case, it will often be possible to eradicate the tuberculous disease at the time of the operation; the dressings will be few, and the after-use of the curette only occasionally needed.

It has been suggested that some of the loss of power in the fingers and wrist depends on the tendons remaining too long after the removal of the diseased bones, and that shortening of the tendons should be practised. M. Ollier points out that the tendons, though too long at first, and weakened by interference with their grooves and the posterior annular ligament, tend to accommodate themselves to their altered surroundings, and that mobility of the fingers and strength in carrying articles depend much more on the amount of bone removed—and especially whether the tendons are trephined upon,—on the old atrophy and degeneration of muscles, the stiffness of joints, and also on the patience and diligence with which the patient persevered with. Shortening of the tendons is only recommended in cases where the patient has obstinately refused to give

stiff, mobility and power of approximation of the thumb and index will be much more useful than any artificial limb.

The following is one of the cases of excision of the wrist by Ollier's method to which I referred at p. 68 :

Mrs. D., æt. 37. was sent to me in January, 1896, by Dr. Wood, of Dover, with tuberculous disease of the right wrist. There was the usual characteristic swelling on both aspects of the wrist, the fingers were stiff and extended, and the hand useless, but, as yet, there were no sinuses. The personal history of the patient, as well as her age and the local condition, was favourable. Excision was performed by an extension of M. Ollier's median dorsal incision. The pisiform and trapezium were left. Thin slices of the articular ends of the radius and ulna were removed with the saw, but it was only needful to treat the bases of the inner four metacarpals by vigorous curetting. Two lateral incisions were made for drainage. The parts healed quickly. As long as the patient could be kept in the hospital, M. Ollier's directions were assiduously attended to. She persisted, however, in going out in a month, and afterwards attended for a time only, and that erratically. I am indebted to Dr. Wood for the following notes of the case, made in November, 1898, nearly three years later :—"There is some undue prominence and mobility of end of ulna. Power of rotation, pronation and supination, perfect and painless. Hand can be flexed and extended on forearm to about half normal amount. Thumb : Movement of one phalanx on the other, also phalanx on metacarpal, perfect. The thumb can be flexed to touch palm of hand, and also any part of the flexor surface of any of the fingers. Fingers : Movement of terminal phalanges on middle phalanges, and of middle on proximal phalanges, perfect. Metacarpo-phalangeal joints : When the fingers are straight there is just a little flexion at this joint, and normal extension ; but when phalanges are flexed on one another, then the metacarpo-phalangeal joints become quite rigid on attempting flexion.* She cannot make a complete fist. Generally, she has a thoroughly useful, though at present not a strong, hand. Asked whether she does her own washing, she replies, 'Yes, I do it, though I don't like it when the day comes round.'"

In the other two cases a single median incision was alone employed. In these also no sinuses were present. An equally sound and useful hand resulted.

Question of Amputation in Tuberculous Disease of the Carpus.—As has been stated above, tuberculous disease of the carpus more rarely occurs alone and isolated than any other tuberculous joint affection. Thus the existence and degree of other tuberculous lesions, the extent of the disease in the wrist, the age and vitality of the patient, the personal and family history, the presence of albuminuria and lardaceous disease, are some of the chief points which will help in deciding the above question. M. Ollier has recorded seven cases in which, owing to the existence of a cough, hæmoptysis, and suspected or actual disease of the apices, he advised amputation, but performed resection owing to his advice being rejected. The results were not encouraging. While excision of the wrist deserves a trial on a larger scale than it has hitherto received, it should only be attempted in patients whose vitality is sufficient, and who are not handicapped by

* This rigidity at the metacarpo-phalangeal joints was due, in part, to too much attention being given to the phalangeal joints, and to the patient being lost sight of too soon. It is rigidity at the *former* joints which prevents a good result being an excellent one, entailing, as it does, a certain degree of open claw, instead of a closed fist. Anyone reading through the after-histories frequently given by M. Ollier of his cases will be struck by the recurrence of the words : "Je ne puis pas faire du poing."

serious disease elsewhere. Where amputation is decided on it must be through the forearm.

EXCISION OF THE WRIST FOR INJURY.—This will be still more rarely required. Mr. Pye (*Med. Times and Gaz.*, 1879, vol. ii. p. 582) published a case of compound dislocation in an adult.

Some bones were protruding through a transverse rent on the front of the wrist, the radial artery was uninjured, the ulnar could not be felt. The flexor carpi radialis and flexor longus pollicis were torn across. The ends of the radius and ulna were sawn off and the carpal bones removed, piecemeal, until only the trapezium and the distal part of the os magnum, which were apparently uninjured, were left. Strict antiseptic precautions were taken, and the wound healed rapidly. There was a steady regain in power in the wrist and hand, the patient being again able to carry his milk-pails.*

In the rare cases of dislocation of the wrist which are, otherwise, irreducible, in the commoner cases of injury to the lower epiphysis of the radius where reduction is impossible, in compound fractures of the lower end of the radius, partial resection would be indicated. In a later stage, where any of the above cases are not doing well, or have become infected, a complete excision would be best, with rigorous antiseptic precautions; boracic acid fomentations at first, and no sutures.

Excision of Wrist for Gunshot Injury.—Dr. Otis (*Med. and Surg. Hist. of the War of the Rebellion*, part ii. p. 999 *et seq.*) states that ninety-six cases of excision of the wrist, varying much in extent, were returned.

Six of these were complete, and five recovered with the functions of the hand much impaired, but, all things taken into consideration, in a better condition than if they had been submitted to amputation. In the ninety partial excisions, ankylosis and extreme deformity appear to have been common. Generally the hand was strongly deflected to the radial side,† the fingers rigidly fixed, the skin over the projecting end of the ulna irritable and exposed to injury. "With our present experience of excisions of the wrist for injury, it seems probable that recovery unattended by ankylosis is seldom to be anticipated, yet that this result is not disastrous, provided the hand is in good position and the functions of the fingers are in some degree preserved." In a very few, loose, flail-like joints were observed, remediable by apparatus. Gurlt (quoted by M. Ollier), in examining into the results obtained by the German surgeons in the Franco-German war, only found one good result, eight moderately good, six bad, and one very bad.

The chief English authority of his day, Sir T. Longmore, wrote thus on this operation:‡

"Gunshot wounds of the wrist are usually attended with so much injury to the tendons and other structures surrounding the joint that it is scarcely possible in such cases for the operation of resection to produce satisfactory results."

Possibly the advantages of modern surgery and resort to tendon-suture will considerably modify the above opinion and results. The

* Sir W. MacCormac (*Dub. Quar. Journ. Med. Sci.*, 1867, p. 281) published the case of a girl, aged 10, in whom he removed the whole of the left carpus and most of the metacarpus, for a machinery accident, the patient recovering with a useful limb.

† As this appears to be irremediable by any apparatus, Dr. Otis suggests that it should be met by always removing the carpal end of the ulna at the same level with the section of the radius, whenever it is necessary to remove the lower end of the latter.

‡ *Syst. of Surg.*, vol. i. p. 552.

first step will be to render the wound aseptic if possible, to remove any shattered fragments, or to perform a partial excision (according to the amount of damage), and provide sufficient drainage. If the wound suppurate it should be irrigated; and, as soon as possible, the wrist excised. M. Ollier (*Traité des Résections*, t. ii. p. 494) gives an instructive case of primary partial excision (first row of carpal bones and the ends of the radius* and ulna) for a gunshot injury in a lad, æt. 13. The shot had "balled," and the extensor tendons were severely damaged. The case was kept under observation for seven years, and the last report ends: "As far as the daily use of my hand goes, I might say that I have never had a wound."

Mr. Makins, C.B. (*Surgical Experiences in South Africa*, 1899-1900) does not mention any case of injury to the wrist-joint. At p. 237 the words occur: "I never saw any troublesome results from perforation of the carpus." Whether these words will remain true in a war in which both sides come equally and extensively under shell and shrapnel fire has yet to be proved.

Causes of Failure after Excision of the Wrist.—These are, mainly:

1. Persistent sinuses and discharge set up by remaining foci of infective tuberculous granulations, caries or necrosis. Sir W. Fergusson (*Path. Soc. Trans.*, vol. viii. p. 391) showed a specimen in which all the bones were supposed to have been removed by a single incision on the ulnar side. The pisiform, trapezium, and part of the unciform had been left. The movement of the fingers was good, but sinuses remained on both sides communicating with a bare piece of radius. Death took place from phthisis. Mr. J. Hutchinson (*ibid.*, vol. xvii. p. 239) showed a specimen of wrist-joint after partial resection by Mr. Stanley. Though no active caries was present, discharge was kept up by a necrosed bit of bone in a cavity at the back of the carpus. Death here also took place from chronic phthisis. This specimen is figured and briefly described, *Brit. Med. Journ.*, 1874, vol. i. p. 11. 2. Matting and sloughing of tendons, and consequent stiffness of fingers. 3. Phthisis.

OPERATION IN CASES OF OLD MAL-UNITED COLLES'S FRACTURE AND SEPARATION OF LOWER EPIPHYSIS OF RADIUS.

In some cases of Colles's fracture where the fracture has not been reduced and the hand is therefore greatly disabled, if the patient's age and vitality be satisfactory operative steps will lead to great improvement. A long incision is made over the radius on the dorsum, and the line of union exposed by retraction of tendons, division and separation of the periosteum. The union is then dissected through from behind downwards and forwards, the fragments completely detached and placed in correct position. As their surfaces are broad they will remain in position without the aid of wire, &c. As the fracture is now

* It is particularly mentioned that, in sawing the bone, no attempt was made to get above the fissures which ran up into the diaphysis.

compound and the patient not young, splints must be kept on for about four weeks, and some support given afterwards. Passive movement of the fingers should be begun at once, and the wrist moved, carefully, in about ten days.

In separation of the lower epiphysis which has been overlooked, deformity and arrest of the growth of the radius are very likely to follow. This condition must be treated on similar lines, with a view to rectification of the displaced parts. If this step is not taken or fails, removal of part of the lower end of the ulna may be required later on, in order to keep the articular surfaces at their proper levels, and to prevent radial displacement of the hand.

AMPUTATION THROUGH THE WRIST-JOINT

(Figs. 11, 50 and 51).

The value of this operation has been a good deal disputed. It has been thought by some* "that it possesses no particular advantage; the length of the stump is of no great consequence; the flaps, with the numerous tendons in them, may not heal readily." Others† have gone further, and said that the long stump is found by instrument-makers difficult to fit with an artificial hand. That this is certainly not always the case is shown by Mr. H. Bigg‡ from two cases, one a Commander R.N., the other an artisan in the Woolwich Arsenal, both of whom, after being fitted with artificial hands, were able to engage actively in their respective employments.

As the above objections are scarcely sufficient, and as this amputation preserves, if the parts heal quickly, good pronation and supination, it should be practised whenever opportunities arise. These, however, as is shown below, will not be numerous.

Indications.

1. Extensive injuries (gunshot and otherwise) of a hand not admitting of the preservation of any fingers, and in which the damage of soft parts does not necessitate amputating through the forearm. On this subject I would refer my readers to the section on "Conservative Surgery of the Hand," p. 16. 2. Disease of carpus locally too far advanced for excision, or rendered by age, condition of health, &c., inappropriate for excision (p. 76). 3. Cases of failed excision. But in carpal disease the soft parts are often so much damaged by sinuses and other results of the disease that the surgeon is driven to amputate higher up; and where this may not be the case, the articular surfaces of the radius and ulna, owing to disease, have to be removed, the operation thus ceasing to be correctly amputation through the wrist-joint.§ 4, 5 and 6. More rarely still, for the results of palmar

* Sir W. Fergusson, *Pract. Surgery*, p. 325.

† John Bell, *Manual of Surgical Operations*, p. 53.

‡ *Artificial Limbs and Amputations*, p. 83.

§ Disarticulation has these advantages over entire removal of the styloid processes (*vide infra*): (1) There is no risk of necrosis. (2) Rotation of the forearm is not interfered with, the inferior radio-ulnar joint being preserved. The supinator longus is left to powerfully flex the forearm. (4) The styloid process is useful.

suppuration, gangrene, or burns. 7. Some cases of malignant disease, *e.g.*, epithelioma. All the above are rare.

Operations.—As in other amputations where the amount of skin available varies considerably, several methods will be given. The first of these is the best.

Different Methods.

1. Long palmar flap (Figs. 50, 51).
2. Equal antero-posterior flaps (Fig. 11).
3. Method of Dubreuil (Fig. 51).
4. Circular amputation.
5. Long dorsal flap, by Teale's method.

1. Amputation by a Long Palmar Flap (Figs. 50 and 51).—This has the advantage of preserving skin thick, well used to pressure, and abundantly supplied with blood; the nerves are also cut square, and disarticulation is easy.

The brachial artery being secured, the limb is brought to a right angle to the patient's side, and the hand, supinated* is supported by

FIG. 50.



an assistant, or rests on a sterilised towel on a small table. The wrist is now extended, the styloid processes defined, and the thumb abducted so as to make the palmar tissues tense. An incision is next made (on the left side) from the tip of the styloid process of the radius† straight down well on to the thenar eminence, and then curving across (about on a line with the level of the superficial palmar arch‡), and marking out a well-rounded flap by passing over the hypothenar eminence to the tip of the styloid process of the ulna. This flap is next dissected up, without scoring, to ensure its vitality, cleanly off the flexor tendons, as far as the level of the wrist-joint: it should contain on its under surface some of the fibres of the thenar and hypothenar muscles. If this precaution be taken, the flap, if sound, will contain the superficialis volæ and ulnar arteries, and thus run no risk of sloughing. In cases where the flap is damaged it will be wisest in making the flap, to cut all the structures down to the bones. Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii. p. 255) advise that it facilitates the operation to detach the pisiform bone and raise it with the palmar flap; it can easily be dissected out afterwards.

The hand being now pronated and flexed at the wrist-joint, an

* If the operation is, thus, commenced from the front, the hand need only be turned over once. If the dorsum is attacked first, the hand must be turned twice, first to make the palmar flap, and secondly to disarticulate. (Farabeuf.)

† The tip of this is nearly on a level with the intercarpal joint, being $\frac{1}{2}$ inch below and somewhat in front of the styloid process of the ulna. On a level with the latter will be found the line of the wrist-joint. The two furrows in front of the wrist are both below the level of this joint. The lower one corresponds to the upper edge of the anterior annular ligament and the intercarpal joint. If the soft parts are much swollen, comparison with, and measurements taken from, the opposite wrist will be helpful.

‡ This level is usually low enough. If the parts on the dorsum are damaged, the palmar incision may be made longer.

incision, slightly convex, is made across the wrist from one styloid process to the other. The palmar flap being now retracted, the hand is strongly flexed and the joint opened on the outer side first; the soft parts in front and behind are next severed with a circular sweep (the assistant pulling slightly on the hand), the remaining ligaments divided, and the hand removed. At this stage the extensor tendons must be cut boldly and cleanly, otherwise they will be ragged. If the articular cartilages of the radius are diseased, they must be dealt with either by gouging or, if necessary, by a clean section above the articular cartilage, a step which will interfere with free pronation and supination later on. The apices of the styloid processes should in any case be removed, but the base of that of the radius should always be left, if possible, to secure the action of the supinator longus. In amputating at the wrist-joint care should be taken, by keeping the point of the knife towards the carpus, not to open the radio-ulnar joint, so that there be no interference with pronation and supination.

The radial, ulnar, the two interosseous, and the superficialis volæ arteries will probably need securing. Any sinuses present are now scraped out with sharp spoons, and the tendons trimmed. From the facility with which these last slip up into their sheaths, antiseptic precautions should be carefully taken.

Another Method.—This consists in marking out the palmar flap (but not dissecting it up), opening the joint by a dorsal incision as above given, and then cutting the palmar flap by transfixion, the knife being passed behind the bones. As in this method it is difficult to avoid hitching the knife on the pisiform and unciform bones, and to obviate a jagged edge to the palmar flap, and as the flexor tendons, being relaxed, are pulled out by the knife instead of being cut cleanly, I do not recommend it.

2. Amputation by Equal Antero-posterior Flaps (Fig. 11).—The surgeon may be obliged, where the soft parts are scanty, to make use of this method. The objections to it are that if the tissues are thin there is some risk that the cicatrix may be adherent to the bones, and that these will be but poorly covered. During healing the drainage is less satisfactory.

3. Amputation at the Wrist by the Method of Dubreuil* (Fig. 51).—In a very few rare cases, *e.g.*, where the soft parts on the back and front of the wrist are much damaged, perforated by sinuses, &c., this ingenious method may be made use of. But the objection to it is obvious. Where the thumb is sufficiently healthy to afford soft parts for a flap, it should be saved.

The hand being pronated, the surgeon commences, at a point at the junction of the outer with the middle third of the back of the forearm, a little below the level of the wrist-joint, a convex incision, which reaches at its summit the middle of the dorsal surface of the thumb, and terminates in front, just below the palmar aspect of the wrist, at the junction of the outer with the middle thirds of the forearm. The flap, consisting of skin and fasciæ, having been raised, the two ends of its base are joined by an incision at a right angle to the long axis of the forearm. Finally, disarticulation is performed, beginning at the radial side. If needful, the flap may be taken from the hypothenar eminence, by reversing the incisions.

4. Circular Amputation at the Wrist.—This method is only suited to patients with thin, lax skin, and even in them it is often difficult to raise the skin quickly and neatly, for it is here adherent to some of the adjacent parts, as at the base of the hypothenar

FIG. 51.



eminence. Moreover, cutting through such a thin, lax skin may be followed by sloughing, especially if its vitality is impaired by sinuses, &c.

The hand being supported by an assistant, the surgeon draws up the skin of the forearm, and makes his first circular incision through the skin on a level with the carpo-metacarpal joints of the little finger and thumb, encroaching thus upon the thenar and hypothenar eminences, two inches below the styloid processes. The skin being retracted by freeing the soft parts with light touches of the knife, another circular sweep is made just above the level of the pisiform bone, so as to sever cleanly the numerous tendons, together with the vessels and nerves. The joint is then opened, and the styloid processes removed.

5. Amputation at the Wrist by a Long Dorsal Flap.—This method on Mr. Teale's principle is not to be recommended. If a skin-flap alone be taken, its poor vitality, especially if lowered by injury or sinuses, will probably end in sloughing; if the tendons be taken up as well, but little additional vascularity is gained, while the flap tends to be somewhat ragged. If this method has to be employed, the convexity of the flap should lie over the centre of the metacarpals.

LIGATURE OF THE RADIAL ARTERY ON THE BACK OF THE WRIST* (Figs. 7 and 52).

GUIDE.—A line drawn from a point just internal to the apex of the styloid process to the back of the first interosseous space.

RELATIONS :—

IN FRONT.

Skin, fasciæ; branches of superficial radial vein, and of radial and musculo-cutaneous nerves; fibro-fatty tissue beneath deep fascia.

Three extensor tendons of the thumb.

Radial artery
on back of wrist.

OUTSIDE.

BEHIND.

INSIDE

V. comes. Styloid process; external lateral ligament; V. comes
scaphoid, trapezium; carpal ligaments.

Indications.—Few; usually wounds, *e.g.*, by the slipping of a chisel by breaking crockery, &c. In such cases both ends † would, of course be secured, and the surgeon would examine as to injury of any of the extensor tendons (p. 44).

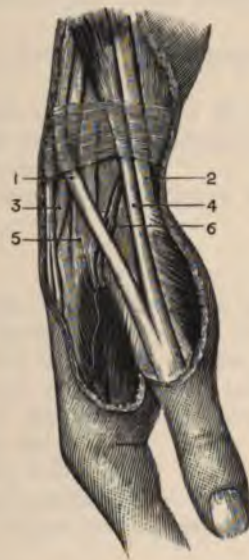
Operation.—The limb should rest upon its ulnar margin, steadied by an assistant, who with one hand holds the fingers, and with the other so moves the thumb as to make the tendons project. In the living subject these should be thrown into action, and their position and the

* The so-called "tabatière anatomique," a triangular space bounded externally by the extensor ossis metacarpi and extensor primi internodii, internally by the extensor secundi internodii; its apex is formed by the meeting of these tendons, and its base by the lower edge of the posterior annular ligament or base of the radius.

† It may be difficult to find the distal end of the artery, owing to its tendency to retract (Butcher, *Operative Surgery*, p. 407).

of the radial vein defined before the operation. The incision, $1\frac{1}{2}$ –2 inches long, may be in the above line or parallel with the tendons. In either case it should be over the lower part of the vessel, just before it dips between the heads of the first dorsal interosseous into the palm. It should be made lightly, so as not to damage the radial vein or, deeper down, the tendons. The radial vein having been drawn aside with a blunt hook, and the deep fascia carefully opened, the tendons are drawn aside as needed and the artery separated from its veins. The ligature may be passed from either side. The artery lies deeper than would be expected, usually covered by fatty tissue. It will

FIG. 52.



Anatomy of radial artery on the back of the wrist. (Heath.) 1, Extensor secundi internodii. 2, Extensor ossis metacarpi. 3, Extensor carpi radialis brevis. 4, Extensor primi internodii. 5, Extensor carpi radialis longior. 6, Radial vessels.

usually be tied between the bases of the first two metacarpals and to the radial side of the extensor secundi internodii. If the parts need relaxing, the hand should be hyperextended. All injury to the closely contiguous tendon-sheaths or joints must be avoided; and, for the same reason, union of the wound without suppuration is particularly indicated here.

In the following case aseptic surgery and the tying of diseased arteries with sterilised silk, and not too tightly, answered well:—

M. A. S., æt. 60, was sent to me, November, 1899, by Dr. Verrall, of the Old Kent Road, with an aneurysm of the right radial artery. Patient, old for her years, was operated on for cataract at 46. Superficial arteries tortuous and hard. No evidence of heart disease. An aneurysm the size of a walnut on the outer and dorsal aspect of the right radius, just where the shaft meets the process join, and extending to the first of the metacarpals. "tabatière anatomique," had begun to form at first of the

had gradually increased till a month before, when it became rapidly larger. November 17 : The radial was tied just above the swelling, and again where the artery dips between the heads of the abductor indicis. Sterilised silk was used, and the veins were included in the first ligature. Specks of atheroma were seen in the radial artery when exposed above. The aneurysm was then incised and a good deal of pink laminated clot turned out. The wound ran an aseptic course ; the aneurysm shrank and disappeared, the only trouble being some dermatitis caused by the iodoform gauze on a very aged skin.

CHAPTER III.

OPERATIONS ON THE FOREARM.

LIGATURE OF RADIAL IN THE FOREARM (Figs. 53, 54).

IN the upper two-thirds the artery is sub-muscular ; in the lower third it is sub-fascial.

LINE.—From the centre of the bend of the elbow (where the artery is given off opposite to the neck of the radius) to a point just internal to the styloid process of the radius.

GUIDE.—The above line, and the inner aspect of the supinator longus.

RELATIONS :—

IN FRONT.

Skin, fasciæ, viz., superficial, deep, and another layer, varying in distinctness, which ties the radial to the supinator longus and pronator radii teres.
Branches of the musculo-cutaneous nerve, especially below.
Superficialis volæ below.
Transverse branches of venæ comites.
Supinator longus overlapping.

OUTSIDE.

Supinator longus.
Radial nerve (middle third).
Vein.

INSIDE.

Pronator radii teres.
Flexor carpi radialis.
Vein.

Radial artery
in forearm.

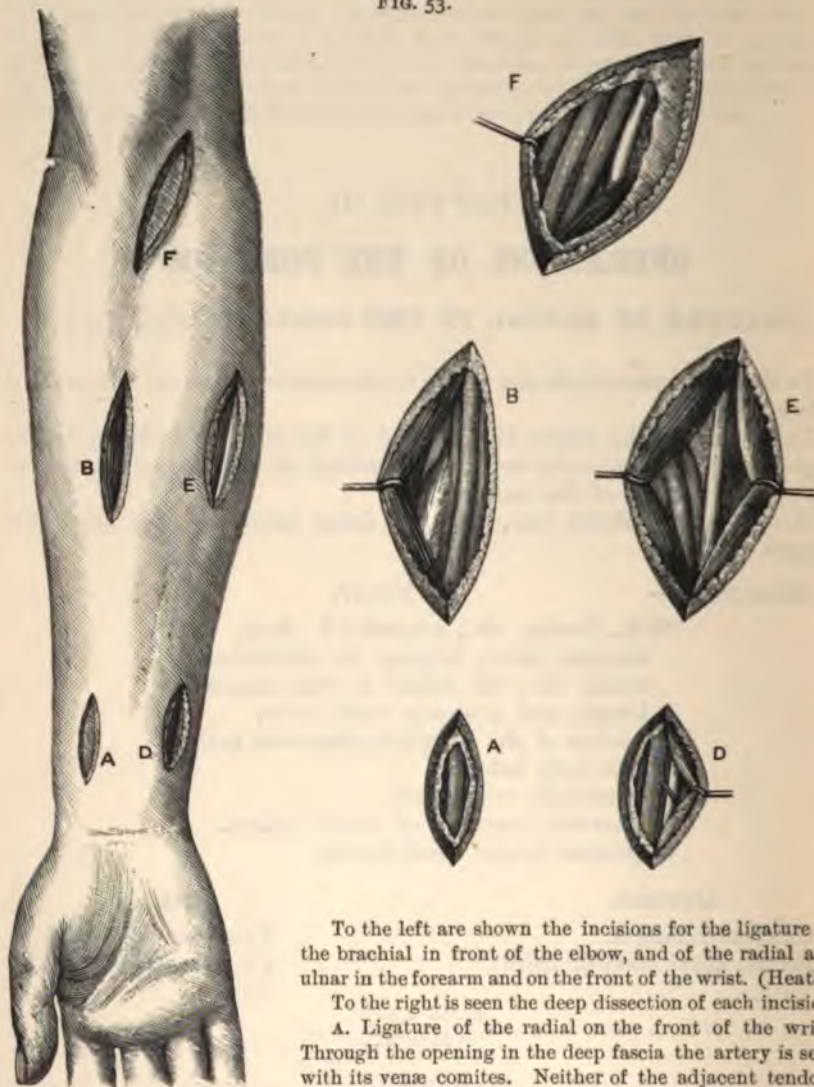
BEHIND.

Biceps.
Supinator brevis.
Pronator radii teres.
Flexor sublimis digitorum.
Flexor longus pollicis.
Pronator quadratus.
Radius.

Indications.

(1) Wounds ; stabs ; cuts with glass, &c. (2) Traumatic aneurysm. In these cases, the limb having been rendered evascular by an Esmarch's bandage, the surgeon opens the swelling, turns out the clot, and ligatures the artery above and below. If he prefers it, he may snip

FIG. 53.



To the left are shown the incisions for the ligature of the brachial in front of the elbow, and of the radial and ulnar in the forearm and on the front of the wrist. (Heath.)

To the right is seen the deep dissection of each incision.

A. Ligature of the radial on the front of the wrist. Through the opening in the deep fascia the artery is seen with its venæ comites. Neither of the adjacent tendons has been exposed.

B. Ligature of the radial in the forearm. The supinator longus has been drawn aside. The radial vessels are lying here on the insertion of the pronator radii teres. The radial nerve is indicated in shadow, lying external to the vessels and on a rather deeper plane.

D. Ligature of the ulnar on the front of the wrist. The process of deep fascia given off from the flexor carpi ulnaris has been opened and drawn aside, exposing the ulnar vessels, with the nerve lying internal to them.

E. Ligature of the ulnar in the forearm. The flexor carpi ulnaris internally, and the flexor sublimis externally, have been drawn aside. The ulnar vessels, nerve, and part of the flexor profundus are seen at the bottom of the wound.

F. The brachial artery, with its venæ comites, is seen to the left, the median nerve to the right. All these are represented as somewhat too large. Some fibres of the pronator radii teres are shown in the lower angle of the wound; a few of the brachialis anticus are seen more deeply.

out the swelling and twist both ends of the artery. The first method is, on the whole, the most generally applicable. (3) Punctured wounds of palmar arch. Ligature of the radial and ulnar is preferred by some, but I would refer my readers to the remarks at p. 36.

A. Ligature in the Lower Third of the Forearm (Figs. 53, 54).—The forearm having been completely supinated and the wrist extended at first, the surgeon, seated comfortably, makes an incision, 2 inches long, midway between the tendons of the supinator longus and flexor carpi radialis, or (if there be much swelling) exactly in the line of the artery, going lightly* through the skin and subcutaneous tissue. A large branch of the radial vein, which is usually met with subcutaneous and just under the incision, is now drawn aside or divided between two ligatures. The deep fascia, here very thin, is slit up on a director, and the wrist now flexed to relax the parts. The artery being separated from the *venæ comites*,† the needle may be passed in either direction. Damage to any of the tendon-sheaths should be most carefully avoided.

B. Ligature in the Middle Third of the Forearm.

GUIDE.—Line of artery (p. 85).

RELATIONS (p. 85).—The nerve is now on the outer side of the artery, but not very close to it.

The steps are very much as above, but the artery is lying deeper. The radial vein, if present, must again be avoided. The incision over the middle third of the artery should be $2\frac{1}{2}$ inches long, and the parts well relaxed when the deep fascia is opened; the inner aspect of the supinator longus is next defined, and this muscle drawn well outwards. The layer of fascia which unites the artery to the supinator and pronator must now be opened. The needle should be passed from without inwards.

FIG. 54.



Determination of the centre of the bend of the elbow. The left index is placed upon the epicondyle, the right upon the epitrochlea, while the right thumb occupies the centre of the fold of the elbow, to the inner side of the biceps tendon which projects beneath the soft parts. The line of the radial artery has been traced in its intermuscular furrow. (Farabeuf.)

* So as to avoid the radial vein, which always, and the superficialis volæ, which sometimes, lie superficial here, the one over and the other just under the deep fascia, which is very thin. On the dead subject, especially, it is easy for the student to get down to or below the artery with his first incision.

† These, owing to the free collateral venous currents, may be tied in if it is found very difficult to separate them from the artery.

C. Ligature in the Upper Third of the Forearm (Figs. 53, 54).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS (p. 85).—The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow-triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least $2\frac{1}{2}$ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with fine sterilised silk ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 53, B), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles having been relaxed by bending the elbow- and wrist-joints, and the cellular interval between them opened cleanly with a knife, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM

(Figs. 53, 54).

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two-thirds of the vessel will be a line drawn from the tip of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM:—

IN FRONT.

Skin; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous
nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.

Flexor digitorum sublimis.
Vein.

INSIDE.

Flexor carpi ulnaris.
Ulnar nerve.

Ulnar artery
in forearm.

BEHIND.

Brachialis anticus.

Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 85.

Ligature in the Lower Third of the Forearm (Fig. 53).—Position of hand supinated and not too strongly dorsiflexed, to begin with. An incision, commencing just above the pisiform bone, and 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. This varies: sometimes it is extremely thin; at others a second process is present, given off from the flexor carpi ulnaris, and tying the ulnar vessels and nerve to the flexors of the fingers. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third* of the Forearm (Fig. 53).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins having been drawn aside or secured with double ligatures, and the wound wiped dry, a white line,† which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here having been carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this wiped dry, and the artery looked for. The nerve, which lies to the inner side, and joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it if possible (footnote, p. 87), the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject, owing to the depth of the vessel, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination-test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb. 2. Making the incision too short, or too much to the inner or the outer side, and

* The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

† This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the

thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor profundus, or that between the flexor sublimis and the palmaris longus.

Aids.

1. Keeping carefully to the above-given line. 2. Hitting off the right intermuscular septum and corresponding sulcus. 3. Finding a muscular branch, and using it as a guide to the artery.

If a wrong space is much opened up in the living subject, the contiguous muscles should be brought together with sterilised silk sutures cut short, due drainage being provided, if needful.

EXCISION OF THE RADIUS OR ULNA.

Indications.—(1) New growths, especially myeloid; (2) Tubercular osteitis, *e.g.*, of the lower end of the radius, caseating, and resisting erosion. It is only in the last class of cases that any special difficulty will occur, and it is to these, accordingly, that the following account applies.

Operation for Removal of the Radius.—This is the bone of the forearm in which myeloid sarcomata usually originate. The following is taken from a most successful case by Mr. H. Morris (*Clin. Soc. Trans.*, vol. x. p. 138), in which he removed the radius and ulna extensively, for a myeloid growth originating in the former, and firmly attaching the ulna to it.

Esmarch's bandage having been applied, a long incision was made over the outer side of the radius, from the styloid process to the upper third. The radial nerve was used as a guide to the interval between the supinator longus and extensor carpi radialis longior, Mr. Morris having found on the dead subject that he could most readily separate the soft structures from the front and back of the radius by going between those muscles, and keeping the supinator to the fore part of the incision. The supinator longus and pronator teres at their insertions having been detached from the radius, the bone, when freed of its muscles in front and behind, was sawn through at the lower edge of the supinator brevis. A second longitudinal incision of less extent than the first was made along the inner side of the ulna from the wrist-joint upwards, and through it the rest of the soft parts separated from the tumour and ulna. This bone was sawn between 3 and 4 inches above the wrist, and the lower ends of both bones disarticulated by opening the wrist-joint on the inner side. The entire tumour, with the ulna and pronator quadratus, was then removed *en masse*. The anterior interosseous artery was divided just above the pronator quadratus, but no other large branches were injured. As soon as a light leather splint was moulded on to the forearm and wrist the usefulness of the hand steadily increased. Four years later Mr. Morris brought the patient before the Clinical Society (*Trans.*, vol. xiii. p. 155, pl. vi.). There was no recurrence. By the aid of a leather splint the patient was able to nurse, dress, carry, and wash and care for her children, do her household work, and wash the house-linen. She could also stitch and darn, and pick up a pin. Latterly, since contraction had taken place, she could hold her hand out straight without any support.*

In 1896 a girl of 13 came under my care with tubercular osteitis of the lower end of the right radius, with two sinuses on the outer and dorsal aspect of the bone, the result

* After these operations, as in any in which the flexors and extensors of the fingers must, of necessity, be meddled with, passive movement of the fingers should be commenced very early and energetically persevered with.

of previous operations. Amputation of the forearm had been advised at a provincial hospital. The extensor communis was the seat of a ganglion, which on removal proved to be also tubercular. The epitrochlear gland was also involved. As repeated erasion failed to bring about a cure, I removed the lower end of the radius. When the patient was seen, in March, 1899, the hand was displaced outwards and weaker than its fellow, but otherwise as useful. Healing was everywhere sound. The movements of the fingers were excellent. No apparatus was required.

Operation for Removal of the Ulna.—In the very much rarer cases of myeloid tumours springing from the ulna, the following may be the course adopted. The account is taken from a paper by Mr. Lucas (*Clin. Soc. Trans.*, vol. x. p. 135).

A longitudinal incision, about 4 inches long, exposed the tumour between the flexor and extensor carpi ulnaris. In making this the dorsal branch of the ulnar nerve was divided. The soft parts having been next retracted, the bone was exposed above the level of the tumour, and sawn through. The piece connected with the tumour was next drawn out of the wound, while the interosseous membrane was divided, and the extensor indicis on the posterior, and the pronator quadratus on the anterior, separated from the tumour. The removal was completed by dividing the ligaments of the lower radio-ulnar joint, the attachment of the triangular fibro-cartilage to the ulna, and the internal lateral ligament. The patient left the hospital in five weeks, the resulting usefulness being excellent.

Mr. Clutton has reported three instructive cases of endosteal sarcoma of the radius (*Clin. Soc. Trans.*, vol. xxvii. p. 86*). Two of the cases affected the lower end of the bone. In one not only the lower end of the radius (the diseased bone), but that of the ulna also was removed,† “so that the hand might be left in a straight line with the forearm.” The result of this step was that, while the limb was useful in the patient’s occupation — that of a painter — as long as he wore a leather gauntlet, without this aid he could do nothing.‡ Examination of the specimen showed that the ulna was quite free. A point of especial interest in this case is the fact that on examination of the sawn section of the radius a small nodule of growth was seen still left in the medullary canal. This was scraped and gouged away. In the second case, also of the lower end of the radius, amputation was performed, as the growth was thought to be parosteal or periosteal. Examination of the specimen showed that it was endosteal, and Mr. Clutton allowed that a free incision might have shown that resection and saving the hand were possible. The third was a myeloid growth of the upper end, head and neck, of the radius. This was successfully removed by an incision on the outer side over the most prominent part of the tumour, “the radius being divided an inch below the growth.” This patient died, eighteen months later, of renal disease present before the operation. No recurrence took place in

* An abstract will be found in the *Lancet*, Feb. 3, 1894, p. 270.

† I would most strongly dissuade my readers from taking this step. Only the bone affected should be removed. Lateral displacement of the hand will follow, but it will not be a flail, and, as contraction takes place, the hand will rapidly gain strength, and no apparatus, requiring frequent renewal, will be needed.

‡ Two years after the operation “the strength of the hand was steadily increasing,” but nothing is said of the amount of support required.

any of the three cases. Slowness of growth and regularity of expansion of the bone seem to be the most important guides in the diagnosis of endosteal from periosteal sarcomata, and in the choice between such steps as resection or erosion and amputation. Crackling and pulsation are also very valuable, if present. Skiagraphy will also help. The first two were absent in all Mr. Clutton's cases, and it is noteworthy that, while the growth which involved the upper end of the radius appeared to be exceedingly hard and resistant, as if entirely bony, it turned out to be soft, almost diffuent. A free exploratory incision is the only reliable guide,* as it is certain that the malignancy of endosteal sarcomata varies within wide limits, some growing slowly and evenly inside the bone, others perforating it in one or more places. On this point my readers should refer to the case of giant cell sarcoma of the head of the humerus referred to at p. 200. In such cases, after resection, the patient should be watched carefully and for several years.

Further remarks on the treatment of myeloid growths will be found in the Surgery of the Lower Extremity, when those affecting the head of the tibia are considered (*q.v.*).

Excision of the Radius and Ulna in Military Surgery.—

By this is meant deliberate removal of portions of these bones damaged by gunshot or other injuries, not the mere picking away of spicules and fragments.

Dr. Otis† divides the cases into the three groups of primary, intermediary (before the thirtieth day), and secondary (after the thirtieth day). Though caries and attempt at repair were met with in these latter cases, there was no time for invagination of sequestra. Thus they were very different from necrosis operations, and hence, in great measure, the high mortality. Of the primary 10 per cent., and of the intermediary 19 per cent., ended fatally; the mortality of the secondary was nearly as high as that of the primary excisions.

The concluding observations of Dr. Otis are worthy of the most careful attention of military and naval surgeons:

"Of this large number of excisions in the continuity of the forearm there is little to remark save that, in the aggregate, the mortality of shot-fractures of the bones of the forearm appears to have been sensibly augmented by operative interference, and that I have sought in vain for a single instance in which a formal excision of a portion of the shaft of either radius or ulna had a really satisfactory result as regards the functional utility of the limb. The representations of Baudens of his Algerian experience led the German surgeons to practise these excisions in the shafts of long bones to some extent in the Danish and Austrian campaigns, with very unsatisfactory results. Similar operations were resorted to with comparative frequency during the American war, and the results plainly indicate, I think, that formal primary operations of this nature should be banished from the practice of military surgery. It is bad enough to remove adherent primary sequestra, for our museum abounds in examples where such fragments have retained their vitality and maintained the continuity of long bones; it is worse to deliberately remove unoffending healthy portions of the bone. The mortality, greatly exceeding that of the expectant conservative treatment, the numerous consecutive

* Involvement of the soft parts, especially when these are complicated and difficult to deal with, as in the case of those around the head of the tibia as compared with those around the lower extremity of the radius, and extensive implication of the medulla, will be the chief indications for amputation.

Med. and Surg. Hist. of the War of the Rebellion, pt. ii, p. 935 et seq.

amputations, and the large proportion of the hopelessly deformed limbs sufficiently condemn such operations. I have found nothing in the reports of the surgery of the late Franco-German war that was not conformable to these conclusions."

Sir T. Longmore (*System of Surgery*, vol. i. p. 544) brings the following striking experience to bear on these cases:

"I have seen many of these fractures in which primary resection of a portion of the entire shaft by a shot has occurred, and have not met with bony union in any case where the gap was a full inch in amount."

Causes of these Resections doing Ill or Failing.

- | | |
|-----------------------------------|---|
| 1. Osteo-myelitis. | 6. Non-union. False joint. Flail-like limb. |
| 2. Pyæmia. | |
| 3. Hætic. | 7. Displacement of the hand at the wrist. |
| 4. Hæmorrhage. | |
| 5. Painful, irritable cicatrices. | 8. Permanent contraction of flexor or extensor tendons. |

AMPUTATION OF THE FOREARM (Figs. 55 to 58).

Practical Anatomical Points.—In this frequently performed operation the following should be kept in view:

(a) The two bones are not fixed, like those in the leg, but movable. This mobility may prevent their being parallel when the knife is sent across in transfixion, and thus lead to penetration of the interosseous membrane: it must also be remembered in sawing the bones. Lastly, on this mobility in pronation and supination depends the usefulness of the stump, which must therefore be left as long as possible, the bones being always, when practicable, sawn well below the insertion of the pronator radii teres into the middle of the outer surface of the radius. If the bones be divided above the insertion of the pronator teres, the radius will become supinated and further rotation movements will be lost.

(β) In the upper part of the forearm, both in front and behind, are fleshy bellies; below, the soft parts are increasingly tendinous. Furthermore, the anterior border of the radius and the posterior of the ulna, especially the latter, are largely subcutaneous.

Different Methods.

- | | |
|--|-----------------------|
| 1. Skin flaps, antero-posterior or lateral, with circular division of muscles, &c. | 3. Transfixion flaps. |
| 2. Modified circular method with equal anterior and posterior flaps. | 4. Circular. |
| | 5. Teale's. |

I. Amputation of the Forearm by Skin Flaps, with Circular Division of Muscles, &c. (Figs. 55, 56, 57).—While, in an amputation so often called for, it is well to practise several methods, none, on the whole, answers so well as this, for the following reasons: (a) By cutting one flap a little longer than the other, sufficient skin can always be obtained to give a good stump. (β) Transfixion, while quite unsuited to the lower third, owing to the numerous tendons, can only be performed in the upper third in moderately muscular forearms

with ultimate satisfaction. For in a bulky, fleshy limb (as in a case of accident in a male adult) it is not easy always to cut the skin longer than the muscles in bringing out the knife, and so to prevent the tendency of the fleshy bellies to protrude while the flaps are being united; and a little later, these muscles, with large surfaces cut obliquely, give rise

FIG. 55.



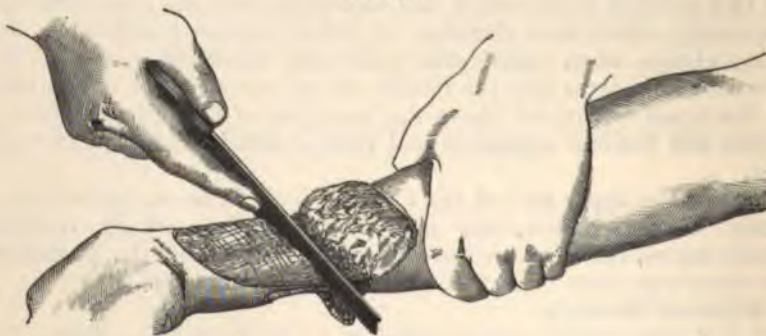
to a good deal of blood-stained oozing, which is very likely to cause tension, suppuration, and delay in healing.

The brachial having been secured with an Esmarch's bandage, the arm extended from the side, with the forearm pronated and the hand steadied by an assistant, the surgeon, standing outside the limb on the right, and inside it in

the case of the left side, places his left index and thumb on the borders of the radius and ulna, at the spot where he intends to saw the bones (Fig. 55). The point of a narrow-bladed knife (about 4 inches long), or a small catlin, is then inserted just below the index, carried along the bone for 3 inches, then curved suddenly across, so as to mark out a broadly arched, not a pointed, flap (Fig. 56), and finally carried up along the bone nearest to the surgeon to a point just below the thumb.

This flap is then dissected up, consisting of skin and fasciæ, and of even thickness throughout.* The forearm is next raised by the

FIG. 56.



assistant holding the hand, so that its palmar aspect faces the surgeon,† who marks out, by a curved cut joining the two horns of the other incision, a similar flap on the anterior surface, but one only about 2 inches in length. This flap having been raised and both retracted, the soft parts are divided with a circular sweep close to the base of the flaps, this being repeated once or twice till the bones are quite exposed. The knife is then passed, with due care of the severed arteries, between

* The under surface of a so-called skin flap should always, when possible, show a few muscular fibres; this shows that the deep fascia is present, in which the vessels run down to send up branches to supply the skin.

† Care must be taken to keep the bones parallel, now, and throughout the operation.

the bones, so as to divide the interosseous membrane, and the periosteum next cut circularly where the saw is to pass. The bones are then sawn through, with the following precautions:—The heel of the saw having been placed on the bones, it is drawn lightly, but firmly, towards the operator two or three times, so as to make a groove. With a series of light sweeps, in which the whole length of the saw is used, the two bones are then cut through together,* the limb being kept

FIG. 57.



(Farabenf.)

supinated during the use of the saw, so as to keep the bones as parallel as possible.

The assistant in charge of the lower part of the limb must be most careful to hold it steady: if he depress at all, the bones will certainly splinter when half sawn through; if, on the other hand, he raise the parts, the saw will be locked.

Any tendons requiring it are then trimmed, nerves cut short and square, and the vessels ligatured or twisted. These are usually four—viz., the radial, under cover of the supinator longus, close to its bone; the ulnar, covered by the flexor carpi ulnaris, on the front of the ulna.

* Some advise that the more movable radius should be divided before the section of the ulna is completed. If the saw is used lightly and swiftly, both bones will be sawn simultaneously. The student usually commits these faults in the use of the saw—he bears too heavily on it, thus locking it or fracturing the bone, and he makes but short sweeps, using half of the instrument only.

Their respective nerves are good guides to the arteries, save quite low down, when the radial has gone to the back of the limb. The anterior interosseous is found on the front of the interosseous membrane, and the posterior interosseous between the deep and superficial extensors.

If the surgeon prefer it, instead of having the forearm raised so as to face him (Fig. 57) while he shapes the flap from the anterior or flexor surface, he will tell the assistant to completely supinate the forearm, and proceed to make the flap with the limb in this position.

If, owing to the condition of the soft parts, **lateral flaps** are preferred, the limb having been pronated, the surgeon marks the site of bone-section with his left forefinger and thumb placed on the centre of the extensor and flexor aspects of the limb at this level. Then, looking over the forearm, he enters his knife in the middle of the flexor surface, and carries it, cutting a broadly arched flap, about $2\frac{1}{2}$ inches long, to a corresponding point on the centre of the back of the limb, and then from this point down again over the side nearest to him, to the spot where the knife was first entered. The flaps are next dissected up with the precautions already given, and the operation completed as before.

2. Modified Circular Method with equal Anterior and Posterior Flaps.—As in this method the antero-posterior flaps being of equal length seldom have to be more than $1\frac{1}{2}$ inches long, the bones can be divided at a lower level than any other, and thus the largest possible stump (p. 93) is given, Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, part iii. p. 246) advise this method. While the scar lies directly over the ends of the bones, they consider this the point of least pressure because the pressure of an artificial limb here must fall either upon its anterior or posterior aspect, and not upon the end of it, as is the case in the lower extremity. The correctness of this arguing must depend on the patient's occupation. If it be one involving pushing, as in the use of a plane, it is difficult to see how the face of the stump and the scar will escape pressure. The limb being abducted and fully supinated, the surgeon standing to the right of the limb places his left forefinger and thumb on either side of the limb at the point proposed for division of the bones. The knife is then entered about half-an-inch below one of these points and is made to trace a short anterior flap terminating at a corresponding point on the opposite side. When this is done a similar posterior flap is marked out. In a forearm of ordinary size the lower limit of the flaps will be about $1\frac{1}{2}$ inches below the seat of circular division of the muscles, and this again about $1\frac{1}{2}$ inches from the point of section of the bones. The periosteum is divided cleanly right round the bones and then stripped up with a rugine (Fig. 66), together with the muscles. This provides a cap of periosteum for the cut ends of the bones and a nicely rounded end for them, and in the forearm guards against a fusion of the cut ends, which would cause a loss of pronation and supination. The muscles should never be first stripped off the periosteum, and the latter then separated from the bones.

3. Amputation of the Forearm by Transfixion Flaps (Fig. 58).—In the case of a moderately muscular forearm the surgeon may make use of this method in amputating through the middle of the forearm. For reasons already given (p. 94), this method is not recommended,

but the rapidity with which it can be done commends it to the notice of those who may have to treat wounded in war on a large scale, or railway accidents where more than one limb requires amputation. The limb being abducted, and the forearm supported and pronated, with the bones as parallel as possible, the surgeon, standing outside the right and inside the left limb, lifts up the soft parts* at the spot where he intends to saw the bones, and sends a narrow-bladed knife (4 to 5 inches long) across the limb, entering it and bringing it out just above the bones. He then, by cutting downwards and forwards, shapes as broad a flap as possible with a steady sawing movement, taking care, before bringing out the knife, to cut the skin longer than the muscles by continuing the use of the knife after the latter are felt to be cut through. The flap should be 3 to 4 inches long, according to the condition of the tissues on the other side, each flap being made as broad as possible and bluntly rounded as it is finished.

The tissues on the front are then lifted from the bones and transfixed by passing the knife across immediately above the bones at the base of the first-made flap, the limb being now supinated. As in this second transfixion the skin on the farther side of the limb may be punctured, it is well for the surgeon to hold down its cut edge with a finger. The second flap is then cut, broad, well-rounded, and $2\frac{1}{2}$ to 3 inches long, according to the length of the anterior. In making either flap, while the muscles are being severed the wrist should be kept flexed. The flaps are then retracted, the soft parts severed with a circular sweep, the interosseous membrane divided, and the rest of the operation completed as in the method first described (p. 94). If this method is used the nerves should always be cut short and square; otherwise painful, bulbous ends may follow.

A very rapid and effective modification of the above is the following: As, owing to the inequality of the soft parts on the back as compared with those on the front of the forearm, and also from the proximity of the ulna to the surface here, transfixion of a dorsal flap is not always easy, a quicker method is as follows:—A skin flap, $3\frac{1}{2}$ inches long, broad and well rounded, being marked out on the posterior aspect of the limb, the knife is immediately, without being taken off, pushed across in front of the bones and made to cut a flap, by transfixion, $2\frac{1}{2}$ inches long, the skin being cut longer than the muscles (*vide supra*). The dorsal skin flap is then dissected up, the flaps retracted, and the bones cleared as before.

FIG. 58.



(Fergusson.)

* This step is most useful—in fact, essential. It is often forgotten.

4. Amputation of the Forearm by the Circular Method.

This method is not recommended here, owing to the flat shape of the limb and the adhesion of the deep fascia above to the muscles. It is especially unsuited to cases where the soft parts are matted by inflammatory changes, or where rapidity of operating is required. It is best suited to amputation in the lower third. It may be performed as follows :—The surgeon, standing outside the limb, which is kept supinated, having drawn the skin well upwards, passes a knife under the forearm, then above, and so around it till, by dropping the point vertically, the back of the knife looks towards him, and its heel is resting on the part of the forearm which is nearest to him. An incision is then made circularly through skin, superficial and deep fasciæ,* round the whole circumference of the limb, $2\frac{1}{2}$ inches below the point where the bones are to be sawn. The completion of this circular sweep is aided by the assistant in charge of the limb rotating it so as to make the tissues meet the knife. The forearm is supinated at first, but may be pronated later, while the cuff is being dissected from the posterior surface.

A circular cuff-like flap of tissues having been turned back as high as the point of bone-section, a second and much firmer circular sweep is made here through everything down to the bones, this being repeated till all the soft parts are cut clean and square. If there is any doubt about the sufficiency of coverings to the bones, the soft parts around these may be freed a little higher (care being taken not to prick the radial or ulnar); the soft parts are then vigorously and firmly retracted, and the bones sawn through, with the precautions given at p. 95.

* If, in raising the cuff-like flap, muscular fibres are seen on the under surface, the presence of the deep fascia and, thus, a sufficient blood-supply will be better assured than by the quicker method of simply peeling the skin and subcutaneous tissue off the deep fascia.

CHAPTER IV.

OPERATIONS IN THE NEIGHBOURHOOD OF THE ELBOW-JOINT.

AMPUTATION AT THE ELBOW-JOINT (Figs. 59, 60).

THIS operation gives excellent results, good flaps being obtainable from the thick soft parts in front, and from the skin behind which is well used to pressure. Furthermore, there are no bones to saw.

It has not been performed so often as it might have been, owing, perhaps, to the belief which some surgeons have held that cartilaginous surfaces left in a wound are a source of delay in healing—an opinion no longer of importance in modern surgery; from the fact that any disarticulation, however simple, is considered to complicate an amputation; and because, owing to the expanded end of the humerus, the flaps required are somewhat larger than in amputation through the lower third of the humerus. New growths of the forearm, and, occasionally, crushes are the chief indications.

Practical Points.

(a) The internal condyle is nearly $\frac{1}{2}$ inch below the level of the external. (β) The joint is opened most easily on the outer side, where the head of the radius is the best guide. (γ) There are masses of muscles on the front and sides; of the latter, those on the outer side (owing to the presence of the supinator longus) retract more powerfully than those on the inner. (δ) The skin on the back of the joint is well used to pressure, and is connected by fibrous bands to the back of the ulna.

Methods.—Owing to the vascularity of the parts, any of the following may be made use of. I would advise the student to practise the first four especially.

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|--|--|
| i. Long anterior flap with short posterior (Figs. 59 and 60). | iii. Lateral skin flaps, or a single lateral flap. |
| ii. A large antero-internal flap and a short postero-external one. | iv. Miller's modification of the circular method. |
| | v. Circular method. |
| | vi. Long posterior flap. |
| | vii. Long anterior flap. |

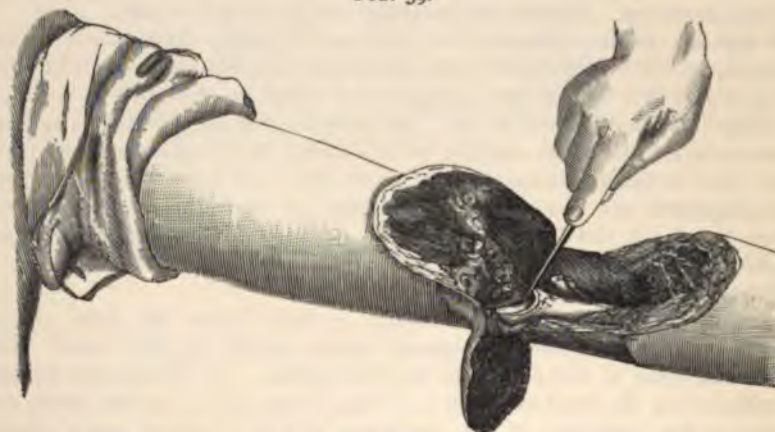
i. Long Anterior Flap (usually by Transfixion) with Short Posterior Flap (Figs. 59, 60).—This method gives an excellent covering to the front of the humerus, allows of easy drainage, and preserves skin which is well used to pressure.

The brachial being controlled a little above its centre,* the forearm

* The assistant who has charge of the Esmarch's bandage, and who is steadying the arm, should draw the skin on the back of the elbow-joint somewhat upwards.

being held somewhat flexed and completely supinated, the surgeon standing on the inner side in the case of the left, and outside the right limb, raises the soft parts in front of the elbow-triangle, and sends his knife, held horizontally, across, just in front of the joint. Thus, entering it 1 inch below the internal condyle, and bringing it out $1\frac{1}{2}$ inch below the external one, or *vice versâ*, he cuts a well-rounded flap, 3 inches long, taking care, as the knife emerges, that the skin is cut longer than the muscles. Then, passing his knife behind the limb, and looking over, the surgeon joins the two ends of the base of his first incision by a convex cut through the skin over the back of the olecranon, so as to mark out a flap $1\frac{1}{2}$ inch long. This is raised without scoring, care being taken to keep the knife towards the ulna, for fear of "buttonholes." The two flaps being then held back, any

FIG. 59.



Amputation through the elbow-joint by anterior and posterior flaps, at the moment of disarticulation.

remaining structures in front are severed, the joint is first opened on the outer side, and the forearm removed by dividing the lateral ligaments and triceps.*

During the last steps the assistant in charge of the forearm pulls this away from the arm.

It has been recommended by some to saw off the olecranon and leave it *in situ*, in order to preserve the triceps. Performed thus this step is useless. It would be better, in suitable cases, to suture the sawn process into the flaps, as is advised in finger and Choparts' amputation (*q.v.*) and to watch the result.

The brachial artery is next secured, together with any other vessels which continue to bleed on removal of the Esmarch's bandage. Any nerves which require it are then cut short, drainage provided, if needful, and the flaps carefully united.

* In Fig. 59, by mistake, the operator has been shown commencing disarticulation on the inner instead of on the outer side, which is usually the easier. The flaps also are rather too long. For these errors I, alone, am responsible.

Modifications of the Above.—The flaps can be cut of different lengths, according to the state of the soft parts. If the surgeon prefer to do so, he can cut his anterior flap from without inwards instead of by transfixion, a course which may well be adopted in an unusually bulky, muscular limb. The posterior flap can be made by cutting from within outwards, after disarticulation, but this, while quicker, is usually not preferable.

ii. **Amputation by a Large Antero-Internal and a Short Postero-External Flap.**—This method is recommended by Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii.

FIG. 60.



Completion of amputation through the elbow-joint by anterior and posterior flaps.

The arrows indicate the saw-like action with which the knife should be used.

(Farabeuf.)

p. 258). The elbow is flexed to an angle of 135° , and the antero-internal flap marked out. This begins at the centre of the bend of the elbow and is carried down parallel with the long axis of the humerus for about 3 inches; with the arm at the angle above-mentioned the lower limit of the incision should meet the inner border of the forearm at about this point. The incision is then curved upwards and backwards to the base of the olecranon. A somewhat similar flap is next cut from the external surface, but this should only be about 1 inch long. The soft parts are taken up with the flaps right down to the bone. The operation is then completed by the steps already given.

iii. **Amputation by Lateral Skin Flaps, or by One Lateral Flap.**—The advantages of this method are, that it is very easily done, and

that, if more skin is available on one side than on the other, flaps unequal in length can readily be made. If the surgeon amputate by equal lateral flaps—standing as before, and having his left index finger on the centre of the elbow-triangle and left thumb at the corresponding point behind, he looks over, and entering the knife close to his thumb, marks out, on the side farthest from him, a flap well rounded, and about $2\frac{1}{2}$ or 3 inches long, reaching to the finger in front. He then marks out a corresponding flap from this point, on the side nearest to him, to that where he began. These flaps are then dissected up of skin and fasciæ as thick as possible, the soft parts severed with a circular sweep, and disarticulation performed, beginning at the outer side.

iv. **Miller's Modification of the Circular Method.**—Mr. A. G. Miller, of Edinburgh (*The Scottish Medical and Surgical Journal*, Sept. 1904, p. 193), relying on Desault's dictum that "the simplicity of an operation is the measure of its perfection," recommends disarticulation at the elbow and knee by a method which secures a long single flap by a circular cut. The whole point and simplicity of the procedure depends on the well-known tendency to contraction of the structures on the flexor aspect of a limb, as compared with those on the extensor, after the tissues are divided. At the elbow and knee this tendency is increased by extending the joint, and thus putting the skin on the flexor aspect on the stretch, while the skin on the extensor surface is completely relaxed. The method of procedure is as follows:—The limb being held out quite straight, a circular incision is made $1\frac{1}{2}$ inches below the condyles down to the deep fascia. The skin on the anterior or flexor aspect at once retracts considerably, making the line of incision oblique.

The extensor flap is now dissected up as far as above the olecranon, care being taken to cut on the deep fascia, and so to reflect the subcutaneous deep fascia, and its contained bloodvessels along with the skin. The flap is loose and ample, being taken from a part where the skin is naturally redundant in order to accommodate itself to the normal action of flexion. After reflection of this flap—practically the only one—disarticulation should be performed from the front. It will then be found that there is a long flap on the extensor and posterior aspect, with practically no flap upon the flexor aspect. After the bloodvessels are secured and the nerves cut short, this single flap folds nicely over the condyles, and is easily secured by sutures. Later, the appearance of the stump is very satisfactory.

Mr. Miller has proved by special dissections made by Mr. Whitaker that the vascular supply to the extensor surface of the arm is remarkably good. Two large vessels are supplied to the skin here, one, on the inner aspect, from the inferior profunda and anastomotica, the other, on the outer, from the superior profunda, both running in the subcutaneous cellular tissue.

With regard to the objection that the cicatrix in a circular amputation is usually central and apt to adhere to the end of the bone, Mr. Miller replies that in his modification the cicatrix cannot be central. It is well up on the flexor aspect, and there is no chance of its becoming adherent to the bone. He claims the following advantages for his method:—(1) The procedure is simple, is easily and quickly

performed, and there are no elaborate details to remember. (2) The skin flap from the extensor surface is well accustomed to pressure and to the situation in which it is ultimately placed over the condyles. (3) The scar is in a most favourable position. (4) Much tissue is not required. The operation is, therefore, suitable for both primary and secondary amputations.

v. Circular Method.

The surgeon, standing as before, makes a circular incision round the forearm, $2\frac{1}{2}$ or 3 inches below the joint, going through skin and fasciæ. A cuff of skin is then turned back as far up as the joint, the muscles severed with one or two firm sweeps, the lateral ligaments divided, and disarticulation performed as before. The edges of the wound may be united either horizontally or vertically from above downwards.

EXCISION OF THE ELBOW-JOINT (Figs. 61 to 66).

Practical Points.—These bear upon the success of this operation.

(1) It is a comparatively simple joint, with small articular surfaces readily got at. (2) Its synovial membrane is simple. (3) Its vascular supply is abundant. (4) The surrounding muscles are powerful, ensuring, if they regain firm attachment, excellent mobility. From the above, and from the untoward effects of ankylosis, a natural cure in the elbow is, often, not so useful as that given by excision. This operation should be performed oftener, especially in the first six of the following conditions:

Indications.

(1) Tuberculous disease. Where this has resisted treatment in a patient who shows no sign of tuberculosis, lardaceous disease, &c., where it is the only large joint affected, and where the powers of repair are sufficient. If other treatment fails to promise a sound and useful joint, there is no good losing more time; the muscles will only be more wasted, sinuses will only form more extensively, and the patient's health be more impaired. If caseation has occurred and, still more, if sinuses and mixed infection are present, it will be impossible to remove the disease entirely by excision; subsequent troublesome curettings will be needed, and the risk of a stiff joint is enormously increased. The rule should be, especially in adults, for excision to antedate the above complications. (2) Recent injury and its results. (A) *Primary Excision*.—When the joint is much opened, the cartilages much damaged, when the shaft is intact* and the tissues in front are sound, an excision may be preferable to expectant treatment. If aseptic from the first the operation excludes the risk of acute arthritis, and its certain sequela, a stiff joint. But here, as in excision for disease, the determination and pluck of the patient will be most important factors. And the age of the patient's tissues and organs will have much more weight than the age given, in the decision between excision and amputation. (B) *Secondary Excision*.—When acute arthritis, not yielding to incision and drainage of the joint, has followed on an injury, and

* Linear fracture, running up into the shafts of the bones, may be neglected, as in the case given below (p. 105).

ankylosis is the best result which can be hoped for without operation. In such cases, as the inflamed condition of the bones and soft parts may produce infective cellulitis and osteomyelitis after an operation, it will be wiser, before excising, to wait till the inflammation has somewhat subsided. It must be remembered that, in excision after injury, reaction will probably be greater, suppuration more certain, and a tendency to bony ankylosis more marked, especially if the periosteum is preserved. Sufficient drainage is absolutely needful. (3) Old injuries to the elbow-joint, resulting in stiffness, ankylosis, or, more rarely, pressure on the main vessel or nerve trunks. I hope the following may be useful to my younger readers when the questions

FIG. 61.



The hook in this illustration shows the continuity of the outer head of the triceps with the fascia over the anconeus (Maunder).^{*} Too much of the posterior aspect of the ulna has been cleared.

arise in such cases, whether we should interfere, and, if so, how far we should go. i. Operative interference is justified in cases where the patient is otherwise healthy, and where his future will be seriously crippled. ii. As to the nature of that interference. (A) *Forcible Movement under an Anæsthetic*.—This, often resulting in the “infraction” of some American surgeons, is not to be recommended. The results are rarely good, may be *nil*, and may be followed by serious damage (Wight, *Ann. of Surg.*, Aug. 1893). Where the needful forcible movement is painful and followed constantly by swelling, the patient must decide between a complete excision, performed on liberal lines, and having the

^{*} *Operative Surgery*. Maunder was the first in this country to call attention to the need of preserving the continuity of the triceps with the above-mentioned fascia in order to ensure the return of the power of active extension.

limb put up in a fixed position, at an angle as acute as possible.* (B) *Arthrotomy*.—Opening the joint, division of adhesions, attempted reduction of the displaced bones with the fingers or a blunt hook, will be found a step of very limited usefulness. (C) *Partial Excision*.—This course has been recommended by several American surgeons. Thus, Dr. Wight, of Brooklyn (*loc. supra cit.*), gives four cases of stiff elbow after fracture, in which he removed the lower end of the humerus by an incision made over this bone and the head of the radius. The results would appear to have been satisfactory, but the exact degree of success is not stated. I am of opinion that those same conditions, which, after an injury to the elbow-joint, may interfere with any good result from forcible movement, will also interfere with success after partial excision. I refer to development of osteoid masses in stripped-up periosteum, displacement of part of the torn capsule between the joint surfaces, filling up of the articular cavities with fibrous tissue, deformities at one or more points in the joint owing to overgrowth of the epiphysal line, and lastly, perhaps, ankylosis between the radius and ulna. Some of the above—*e.g.*, the formation of osteoid deposits—will be specially marked in young subjects. Here, owing to their marked reparative power, and the inflammation set up by the injury, the tendency to secondary ankylosis is so great that it will best be met by a free removal of the bony surfaces. Partial excision risks a result of incomplete value—*i.e.*, a joint of limited movement, though one, perhaps, with a useful angle. Where there has been no suppuration and but little inflammation, where the cartilages are not damaged, where there is no fracture present of the articular ends, the surgeon may try in a case of old injury to the elbow-joint—*e.g.*, an unreduced dislocation of both bones backwards,—first, sawing off the articular end of the humerus, the section being supra-epitrochlear (p. 113). If he find that after this step he can place the hand on the shoulder of the same side, and behind the back to the opposite scapula, with perfect freedom and without any locking, he may be content to leave the extremities of the ulna and radius untouched, if his patient be an adult. But if the above given conditions are not present, and from my experience they rarely are, and most especially if there be any separation of part of an epiphysis or process of bone, ripping up some periosteum which has ossified later on, and in all cases in children, he will only secure a movable joint by a complete excision with sufficient removal of bone (p. 113). The following is, very briefly given, an interesting case of excision of the elbow for an old dislocation and fracture :

M. E. W., aged 28, was sent to me in February, 1894, by Dr. E. Davies, of Swansea. The injury, received the previous November while he was riding over a sheep-farm in Tierra del Fuego, had never been treated. A dislocation backwards of both bones of the right elbow-joint was typically evident, and, in addition, there was distinct shortening of the limb, marked coldness and lividity of the hand, and deficient radial pulse. The forearm was fixed at a very obtuse angle, active and passive movements being almost completely abolished. During the excision it was found that a fracture ran obliquely from without inwards through the lower third of the humerus. When the limb was placed in the extended position after the operation, there was still a full $1\frac{1}{4}$ inch between the

* If plaster of Paris be employed, the bony points—*e.g.*, the condyles—must be carefully padded.

bone ends. Healing was uneventful. At the end of four months the patient, a man of undaunted pluck and imperturbable temper, could use the arm to play lawn-tennis, shoot rabbits with a rifle, and ride. Five months after the operation, extension and pronation were practically complete, flexion was full enough to allow of his touching his right ear and buttoning his collar-stud with the right hand, but not sufficiently perfect for him to touch his right shoulder. Only about half the full range of supination was present. In 1895 the patient wrote, saying, "My arm is as useful to me as it was before the accident. I can shear sheep, ride, and shoot with any man." August 29, 1899, he wrote, "This morning I stood in one place and shot six Brent geese coming over, with seven cartridges."

(4) Some cases of injury to the lower epiphysis of the humerus. In the majority of cases, judicious treatment, including, especially, the early examination and reduction of the displacement, *under an anæsthetic*, the putting up of the elbow at a useful acute angle with plaster of Paris with the hand on the same shoulder,* or flexible metal splints (Poland, *Traumatic Separation of Epiphyses*, p. 385, Fig. 99) will suffice. In a certain number more will be required. Such cases fall under the following heads: (A) *Compound Injuries*.—Here an excision on free lines is more likely to bring about a good result than the expectant method, especially if infection take place. (B) *Simple Injuries*.—Excision will be the wisest step here in cases where, four to eight weeks after the accident, the joint remains stiff, at a useless angle, where the ankylosis is clearly intra-articular, not muscular, and where the breaking down of adhesions is constantly followed by recurrent inflammation, pain, swelling, &c. And the operation will be additionally indicated where ankylosis is largely due to osteoid deposits in stripped-up periosteum or to a portion of detached epiphysis, *e.g.*, the epicondyle, having been wedged in between the trochlea and sigmoid cavity, and thus rendering improvement of the position impossible from the first. I am of opinion that in all these cases an excision, to be successful, should be conducted on free lines; that if the surgeon leave the articular surfaces of the radius and ulna he should remove the lower end of the humerus very freely (p. 113); that he should be very careful in testing the freedom and smoothness with which the hand on the affected side can be put through certain needful movements (p. 114). Mr. Poland—in his book, which is a mine of wealth of information, given in the clearest possible way, on subjects often dry and abstruse—is against complete excision in these cases. While I admit that no opinion stands higher than his, my own experience would lead me to recommend it in such cases as I have alluded to above. I am well aware that complete excision in young subjects may lead to a limb shortened by two or three inches, but a shortened upper extremity is of little moment if the hand is rendered thoroughly useful by a mobile elbow-joint, and many besides myself have had abundant experience of the frequency with which ankylosis follows, in these cases of injury to the lower epiphysis of the humerus not excised on sufficiently free lines, owing partly to conditions already alluded to, and partly to the great difficulty of getting young patients to give any assistance in the needful movements of their joint.

* If this simple and efficient method were more frequently used, an anæsthetic being given and care taken to pad all points where pressure is likely to fall, the after-results of these cases would be greatly improved.

The following remarks by Mr. Keetley (*Clin. Journ.*, Feb. 4, 1903, p. 247) on the diagnosis and treatment of the commoner injuries about the elbow-joint in young subjects, characterised by his usual terseness and clear common-sense, will be useful to many. First as to *diagnosis*. For comparison of the two elbows, the patient should place the two hands, one on the other, upon the top of the head, and then bring the elbows as near each other as possible in front of the face. There are, now, two triangles to be compared. The base of each is formed by a line uniting the tips of the two condyles; the apex is at the olecranon. Any effusion into the joint will cause a puffiness between the olecranon and the condyles. If there be a fracture between the condyles into the joint there will be an increase of the distance between the condyles, best measured by a pair of calipers. Fracture of either condyle will disturb the relation of the external or internal condyle to the other two points. If the head of the radius is dislocated outwards or backwards, its head will become more prominent than on the opposite side. A supra-condylar fracture or separation of the epiphysis will be suspected from the large amount of swelling and the pain in raising the injured elbow. The elbows should next be flexed to a right angle at the side, and viewed from behind. X rays should be employed, both a side and front view being taken, and both elbows should be radiographed. In *treatment* the fragment should be accurately reduced, "the ideal to aim at is replacing the fragments as if they were pieces of a puzzle." Extension and manipulations with the aid of an anæsthetic and X rays, if available, are the first and chief points, together with careful comparison of the two sides. Thus, where the external condyle and capitellum are broken off and pushed upwards and forwards, the line between the condyles, instead of being nearly at a right angle to the shaft of the humerus, will cross it obliquely, the external condyle will be felt running more forward than usual, and, when the elbow is flexed, the forearm will move in a plane which slants across the median antero-posterior plane of the arm. If all these abnormalities disappear when the limb is fully extended and supinated, it should be fixed in such a position till the union is firm. If extension and manipulation fail, *the question of operation* must be considered. Here two factors have to be taken into account. (i.) The condition and vitality of the patient and his organs. (ii.) The experience of the operator as to maintaining perfect asepsis throughout. The value of complete reduction, in this instance by operation, is shown by the following case of Mr. Keetley's:

The external condyle and capitellum was doubly rotated, so that the fractured surface lay beneath the skin, the upper end projecting downwards. It was replaced and wired in good position. The boy refused to permit any movements to be made, and ran away from the hospital. A few months later Mr. Keetley found that perfect mobility had been regained.

To sum up the question of operative interference, it should be limited to compound cases, to those (which should be extremely rare) without external wound where reduction with the aid of anæsthesia is found impossible, where, after a few months, deformity is marked or the limb rendered useless, and in cases of nerve injury.

While the surgeon will always be justified in first sawing off t

olecranon, *e.g.*, in a case of unreduced dislocation, I have not, myself, found that this step opens up the joint widely or gives sufficient access. In two cases of dislocation of both bones backwards which came under my care in 1904, one a child three months after the accident, the other a very powerful adult in which only four days had elapsed and attempts at reduction had failed: in each case, after sawing off the olecranon, I was able to effect reduction, but the movements remained so restricted that I resorted to a complete excision. In the case of the child the result was very satisfactory in every way. In that of the adult, while the wound healed quickly, the firm, hard inflammatory swelling, present before the operation, persisted obstinately, and the movements of the joint, seven weeks later, were still disappointingly limited.

Open Operation for T-shaped Fracture into the Elbow-joint or Fracture-Separation of Epiphyses.—The following advice by Messrs. Watson Cheyne, C.B., and Burghard (*Man. of Surg. Treat.*, pt. iii. p. 79), clearly indicate the chief steps. Incisions are made either over the condyles, or the chief one behind, and again over one or both condyles. In any case, care must be taken not to detach the soft parts too freely, or the nutrition of the fragments will be interfered with. Any loose fragments and blood clot are removed. A drill is then made to perforate the two condyles transversely from side to side. Into the drill-hole a plated steel pin or screw, or an ivory peg is driven. The condyles, thus united, are fastened to the shaft by fine screws or wire. In a slighter case, one or both condyles may be wired to the shaft. The limb is put up in a Croft's splint, acutely flexed. If a pin or screw has been used it may generally be removed at the end of the third week, but there is no reason why movements and massage should not be carried on without reference to it, if a piece of gauze soaked in a 1 in 2000 sublimate solution be wrapped round the pin and wound during the massage.

(5) Ankylosis in a faulty position. The following are the chief points which will present themselves for consideration:—How far the angle is an obtuse one, and the position of the limb such as to render it useless; the age and vitality of the patient, and his interest in possessing a mobile joint; the condition of the muscles (for if the ankylosis be of long standing these may be so utterly atrophied that the usefulness of the limb will be but little increased by operation); the co-existence of any cicatricial bands, especially in front, which will interfere with the after-result. A bilateral ankylosis, especially at useless angles and in young subjects, calls urgently for resection, the operations being performed at an interval of about four weeks, and the limb in which the muscles are least wasted being taken first, so that a good result may encourage the patient. The more complete the ankylosis, the more the articular surfaces are fixed throughout (*i.e.*, not at one spot only—*e.g.*, olecranon tip to olecranon fossa), the greater the thickening of the periosteum, the more are osteoid nodules or spicules found scattered about in the ligaments, the more freely must the bones be removed. Further, in all cases of bony ankylosis, the surgeon should examine into the state of the superior radio-ulnar joint, or an ankylosis here may be overlooked after the main disease has been treated. I have no experience of the method of *résection économique* which th

ingenuity of French surgeons has led them to try in cases of ankylosis after injury. Here after a removal of the bones less free than that which I advise, a flap of muscle—*e.g.*, the triceps—is brought between the resected ends and attached to the capsule in front, to prevent fresh ankylosis occurring (Quénu, *Bull. et Mém. de la Soc. de Chir.*, Juin. 27, 1905, p. 622). Perusal of some of the recorded cases leaves the impression on my mind that the result, especially in children, is not superior to that of the older method of a free resection. (6) Disorganising arthritis of elbow after one of the exanthemata, pyæmia, or rheumatic fever. (7) Osteo-arthritis. If the patient is healthy, not advanced in years (*i.e.*, not much over forty) and not broken down, if the muscles are likely to recover their tone, and if this is the only joint attacked. The surgeon must be prepared for sawing very dense bones here. Dr. F. W. Collinson reports a most instructive case of excision of both elbow-joints for osteo-arthritis (*Lancet*, 1899, Nov. 4, p. 1233). The patient, æt. 22, was admitted into the Preston Royal Infirmary, June 30, 1890.

The disease had begun when she was eleven. All the joints were more or less affected. The right elbow was absolutely fixed. When attempts were made to move it under an anæsthetic, the humerus gave way at its lower epiphysial junction. The left elbow-joint could only be flexed through an angle from 8° to 10°. The right joint was excised September 9, the left in December, 1890. Both healed quickly. In August, 1891, there was on the right side almost perfect flexion and extension, with practically no lateral movement. Pronation and supination were absent owing to the absolute ankylosis of the wrist and inferior radio-ulnar joints. On the left side extension was not quite so good, a certain amount of lateral movement persisting. Both hands were now most useful. As an instance of how crippled the patient had been before the operations, when eating she was compelled to place her plate on her knees, she then lowered her head and raised her knees, and thus managed to get her food into her mouth.

(8) For growths of the bones, especially if innocent and affecting one bone—*e.g.*, exostosis.

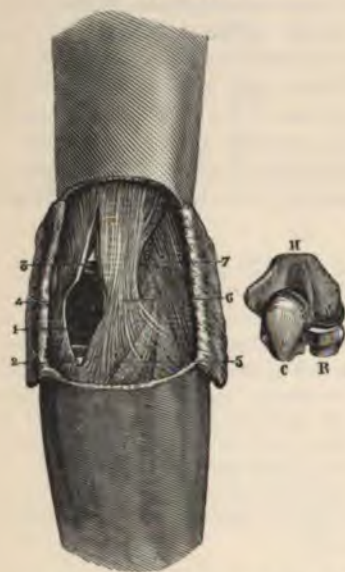
The following points call for consideration in any case where excision of the elbow is being discussed :

1. *Age*.—This must always have much influence. In very young children due attention must be paid to the naturally great power of repair. After thirty-five or forty the surgeon should weigh very carefully all the points of the case, and only excise where all else is favourable. From puberty to thirty-five I consider the best age. Those who see much of the surgery of childhood will, of course, be called upon to decide upon the operative treatment of tubercular disease of the elbow-joint at a much earlier date. During the first three or four years of life resection is not to be recommended. This is partly due to the fact that, owing to the greater tendency to repair, less severe steps—*e.g.*, curetting, removal of tubercular foci of osteitis and caries—will often be sufficient, but partly, as far as my own experience goes, because the surgeon will be driven to hold his hand on account of the feeble, miserable condition of those patients with tubercular disease of a large joint so early in life. Owing to the difficulties, inevitable during the after-treatment, in carrying out active and passive movements, the surgeon must be careful to keep the limb, from the first, at a useful, *i.e.*, an acute, angle. After the age of four, the patients, owing to their increasing vitality and resisting power, are

better fitted for resection, but the activity of the periosteum, together with the fact that it is impossible to rely upon the patients for any help in active mobilisation of the joint, calls for free removal of bone.

2. *Complications.*—These are most likely to present themselves in the shape of diseases of other bones and joints, for such a complication as phthisis calls for amputation. Caries of the metacarpal or metatarsal

FIG. 62.



Right elbow after excision of the joint by the usual posterior incision. (Fara-beuf.) 1 and 4, Cut edges of the outer expansion of the triceps tendon. 2, Ulna. 3, Humerus. 5, Anconeus, covered by 6, Outer expansion of triceps. 7, Supinator longus and radial extensors of the carpus. To the right the bones removed during the operation are seen. The humerus has been sawn through at a point somewhat higher than usual.* It will also be noticed what care has been taken not to unduly expose the shaft of the ulna.

a matter of very great difficulty, rendering the operation much more laborious and prolonged, and it is extremely doubtful if its advantages

bones is not of itself a contraindication. If a diseased spine is present the question of excision will depend on whether the vertebral caries is old, or recent and active. If old, is the elbow a source of much irritation? Two large joints are rarely diseased at the same time. Mr. Holmes (*Clin. Soc. Trans.*, vol. i. p. 143) records a case of a boy, aged 5, where he excised, with excellent results, both elbow-joints—only a few weeks intervening between the two operations. Mr. Clement Lucas (*Brit. Med. Journ.*, 1881, vol. ii. p. 897) relates a case in which disease of the left elbow came on about two years after excision of the right joint, and was also successfully operated on. Since 1886 I have excised the elbow-joint with good results in four children, in whom some years before I had successfully excised a knee-joint. And in one of the four I had, later on, to remove a tubercular tarsus by a Syme's amputation. When this child was seen a year later, all three operation-wounds were sound. The new elbow-joint was a very useful one.

3. *Question of the Value of Preserving the Periosteum.*—While the periosteum may be easily preserved in cases where it is swollen and loose, its preservation is in others

* One of the leading surgeons in London, a former President of the College of Surgeons, who has provided me with some kindly criticisms of this book, has urged me to abolish this drawing, on the ground that removal of so much bone would inevitably reject any candidate. I have warned my readers above that rather too much of the humerus has been shown removed, but as I am convinced that restricted movement is far too common after this excision, owing to too limited use of the saw (p. 113), I venture to retain the illustration.

are equivalent in this joint, where the ordinary operation gives such excellent results.* Some cases—*e.g.*, primary excision for injury—are unsuited to this method, as the unaltered periosteum is most difficult to remove from the irregular bone ends. In tubercular disease it is often unsuitable on account of the risk of leaving mischief behind.

Subperiosteal resection is said to lead to less hæmorrhage, less disturbance of the capsule and attachments of muscles, with greater lateral steadiness and completeness of the new joint. While the last two are undoubted, this step may bring about impaired movement,† and I am of opinion that the surgeon should only trouble to preserve the periosteum, while clearing the lower end of the humerus of its important muscular attachments, especially in cases where an unusually large amount of bone has to be removed. If the periosteum is kept, the removal of the bone will be additionally needed.

Operation.—The single vertical incision at the back gives such excellent results that this operation will alone be fully described; the method by two lateral and a single bayonet-shaped incisions which have the preference by high authorities will be given later. As in all difficult and not very common operations, the surgeon will act most wisely by practising one operation. An Esmarch's bandage having been applied as high as possible over the upper arm which is first well elevated, or the whole limb being rendered evascular as far as the above point by the use of two bandages, the limb is flexed and carried over the front of the trunk, so as to present it fairly to the surgeon, who usually stands on the opposite side of the body.

The surgeon, then, noting the relative position of the condyles and the course of the ulnar nerve, makes a straight incision of sufficient length‡ (about four inches in the adult), with its centre at the tip of the olecranon, a little internal to the centre of the back of the joint, and parallel with the ulnar nerve. This incision should begin above or below as is most convenient, and go down to the bone throughout its whole extent, splitting the triceps muscle and tendon and incising the capsule. Partly with the point of the knife, partly with a *rugine* or elevator§ (Fig. 66), the surgeon then raises, as far as possible in one piece and without tearing or jagging, the outer half of the triceps,

* In the case of excision of the shoulder-joint (p. 208) the conditions are very different.

† A case is given (Langenbeck, *Arch.*, vol. viii. p. 136) in which, after subperiosteal resection, the condyles had been very perfectly reproduced, and the olecranon had been reformed to even an inconvenient extent, for it was so long and curved as somewhat to limit extension. This method should usually be rejected in children, and also in cases of ankylosis, for fear of a recurrence. The candid Prof. Ollier, with all his experience, wrote (*loc. supra cit.*, p. 218), "Aussi, après une résection sous-périostée, est-ce la roideur qui est plus à craindre que la trop grande laxité."

‡ An insufficient incision will only increase the difficulty of the operation, and, by the bruising then consequent upon the strenuous use of retractors, lead to delayed healing and, perhaps, to suppuration.

§ Unless the tissues are softened by inflammation any "blunt dissectors" are useless. Any periosteal elevator—*e.g.*, the one shown in Fig. 66—should have a distinct but not sharp edge. When such are not to hand I prefer a pair of scissors curved on the flat. They make an efficient periosteal elevator, and at the same time afford a cutting edge whenever this is needed. If the knife be used each cut should be short, and, as it is made, the edge must ever be kept turned towards the bone.

which, with its expansion into the deep fascia of the forearm over the anconeus (Figs. 61 and 62)—this latter muscle being taken up at the same time,—is peeled up as thickly as possible from its insertion into the ulna. It is on the preservation of this expansion that the regaining of active extension will depend.

I may here say that resection-knives and elevators of the French pattern (Fig. 66) are the best. A glance at Fig. 66 will show this to any one who is familiar with the difficulties of an excision on a powerful adult for an injury or after ankylosis.

The deeper parts on the outer* side of the joint are then separated from the bones with the elevator and thumb-nail, until the external condyle and head of the radius are completely exposed. The left thumb, all the time sunk deeply into the wound, pushes the flap of soft parts, as it is detached, towards and over the external condyle. It

FIG. 63.



To show the level to which the bones are to be cleared, and the way in which the thumb-nail is kept between the knife and the soft parts.

is, finally, displaced over this, as the joint is flexed strongly. Next, the parts on the inner side should be detached from the inner condyle and inner border of the olecranon, great care being taken, by the following precautions, to keep intact the ulnar nerve:—(a) By keeping the knife or rugine parallel with the nerve and close to the bone; here, and on the outer side, alike, the instrument should follow closely the different bony irregularities around the joint. (b) By the use of the thumb-nail, which peels off the soft parts before the knife. By these means the soft parts will be satisfactorily cleared from the bones; retractors (Fig. 64), well applied, will be found most useful, as the process of peeling off the soft parts is somewhat fatiguing to the thumb. This is especially the case in excision for accidents or on the dead body, and it is in these only that the nerve may be seen, though indistinctly. Where the parts have been long inflamed, they peel off much more readily, and the nerve is buried in the swelling. It is well to remember

* For the sake of practice, it is well to take the outer side first, before clearing the inner, with the ulnar nerve in proximity to it.

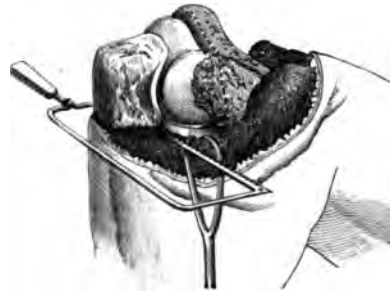
that the nerve may be injured at three places, (1) above, in the inner head of the triceps; (2) behind the internal condyle; (3) below, under the extensor carpi ulnaris.

The clearing of the soft parts off the bony prominences will be much facilitated by keeping the joint extended as much as possible, and the soft parts thus relaxed.

Each lateral ligament, if this has not been already done, is raised, together with the periosteum and the group of flexors or extensors respectively, freed from their bony attachments and pushed over them, and there retained with retractors.

The joint is now strongly flexed, and the capsule opened just above the olecranon. Mr. C. Heath (*Operative Surgery*, p. 101) advised that at this stage the olecranon process be grasped with lion-forceps and sawn off, or, in young subjects, cut off with bone-forceps, as this step "opens up the joint most satisfactorily and saves the trouble of dislocating the ulna." The bone ends are then turned out and prepared for the saw by passing the knife down to the bone, along the lines of intended section, the soft parts being well retracted beyond these lines. In turning out the bone ends it is easy, in patients where the parts are delicate or softened by inflammation, to strip off a needless amount of periosteum—*e.g.*, on the anterior aspect of the shaft of the humerus.

FIG. 64.



To show the application of the saw. The dotted line across the humerus passes above the articular cartilage, but is not high enough (*vide infra*).

SITE OF BONE SECTION.*—

The ulna should be sawn (from behind forwards, with a small Butcher's saw set firmly), so as to remove the greater and lesser sigmoid cavities with the olecranon. The radius is removed at the same time just below its head, above the biceps. Before this is done, the assistant who is holding the forearm should thrust the ends of the bones prominently but carefully (*vide supra*) into the wound. The section of the humerus requires careful attention. An insufficient amount is usually removed here, and limitation of subsequent movement thereby invited. It is generally considered sufficient to remove all the articular cartilage, the section being made to pass through the lower part of the coronoid and olecranon fossæ, and below the level of the epitrochlea on the inner, and through the epicondyle on the outer, side. This is not enough.† The saw should pass at a higher level, *i.e.*, above the level of the epicondyle, and through the highest part of the epitrochlea, removing quite the lower two-thirds of this process. This is the very lowest level at which the surgeon should hold his hand if he desires to

* Refer also on this point to Fig. 62, p. 110, and the footnote.

† If only half an inch of the humerus be removed, together with the head of the radius and the olecranon process—the latter perhaps obliquely—ankylosis is certain

obtain good movement.* And before he is satisfied on this point he should place the fingers of the affected limb not only on the opposite shoulder and the mouth (as is often done), but on the shoulder of the same side, and behind the back to the angle of the opposite scapula. Unless these movements are perfectly free, he should take another thin slice off the humerus, removing the whole of the epitrochlea. This step may seem to my younger readers a needless shortening of the limb, and likely to lead to a flail-joint. I can assure them that it is not so. As long as the elbow-joint is freely movable, shortening of the bones matters very little. If attention has been paid to the advice given at p. 112, and the soft parts separated very carefully and, as far as possible, subperiosteally from the epicondyle and epitrochlea, the joint will become sufficiently steady laterally as well as freely movable although these bony prominences have been widely removed. Another test which the surgeon should always apply before considering the section of the bones completed is the interval between the sawn ends. Prof. Annandale (*loc. supra cit.*) considers that $1\frac{1}{2}$ inch should intervene between them when the bones are extended. This will be none too much in adults, especially in cases where, owing to the condition of the parts, recurrent inflammation is certain. In all cases (and this is especially so in those of ankylosis† where a recurrence of the trouble is to be dreaded) more bone must be removed from the humerus than from those of the forearm, where the section is limited by the attachment of important muscles. The extent of bone to be removed having been detailed, it is well to remember the advice of Prof. Kocher (*Text-book of Operative Surgery*, Stiles's translation from the 4th edition, p. 373) to make the sawn sections curved. It is especially important to do so with the olecranon, as this step goes a long way towards preventing partial dislocation of the forearm forwards. Mr. Holmes has pointed out, long ago, that if, after removing as much bone as is wise, disease is still felt upon the anterior surface, it is not necessary to make further sections so as to get beyond it; thorough curetting will be sufficient, and will save any further interference with the attachments of muscles. Messrs. W. Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. iii. p. 261) give the following advice here, which is one recommendation of the method of two lateral incisions:—"The finger can be made to pass from one incision to the other between the capsule and the superficial structures, amongst which will be the brachial artery. By passing the finger across from one incision to the other and shifting the soft parts upwards and

* M. Ollier (*Traité des Résections*, t. ii. p. 203) usually makes the section at a much higher point than most surgeons. He first states that the section of the humerus may be made at different levels—(1) That which removes the articular surface only, the sub-epitrochlear; (2) That which passes through the substance of the epitrochlea, the intra-trochlear; (3) That which passes just above the epitrochlea, the supra-epitrochlear; (4) That passing through the shaft. He then goes on to say, "The section most frequently made—that which is indicated in the majority of cases of chronic joint-disease, whether in young or old subjects—is the section above the epitrochlea," i.e., number (3).

† In cases of bony ankylosis, it is well, before attempting to make sections of the bones, either to break down the union forcibly (care being taken not to fracture the possibly atrophied bones above and below, or to separate any of the epiphyses); or, better, to divide the ankylosis with a saw, chisel, or osteotome.

downwards, the entire front part of the capsule can be separated, and may be cut across at its attachments to the bones and removed whole.* While the bones are sawn, the olecranon and trochlea of the humerus may be steadied in the grip of a lion-forceps, the soft parts at the sides being well retracted.* Any soft, caseous patches in the bone ends are now gouged, any possible sequestra removed. In bad cases the bones are liable to be fatty, with little natural marrow; such, however, are not necessarily irrecoverable. If the bone above the levels of section appears roughened, and the site of periostitis, this need not be touched; all will probably subside when the cause of irritation is removed. Any sinuses or suppurating pockets should next be laid open, with due regard to the ulnar nerve, and their contents scraped out with sharp spoons. Iodoform emulsion and tampons of iodoform gauze should be inserted, partly for the arrest of hæmorrhage, and partly (in tubercular cases) to promote healthy granulations. One or two points of suture may, perhaps, be inserted, so as to close just the ends of the wound; but all the rest of this should be left open, and a drainage-tube inserted in cases where there is much oozing or where infected sinuses have been present.† Very varied forms of splint have been advised.‡ Some surgeons, to keep the bones apart, from the first put the limb upon some form of right-angled splint; others, fearing a flail-like condition of the joint, prefer to begin with the arm and forearm on a straight splint, or on one with an obtuse angle (about 135° —Ashurst, *Encyclopædia of Surgery*, vol. iv. p. 477). As ankylosis is, in children especially, to be dreaded (*vide infra*), I much prefer to put cases up from the first on a metal angular splint, using some such cheap form as that which I have described in the *British Medical Journal*, 1877, vol. i. p. 774, in which the anterior metal bar supports the limb, while it leaves the wound and its vicinity well exposed and is easily kept clean, both parts being easily boiled in a steriliser; moreover, the movable handpiece readily admits of some early passive pronation and supination. The only objection to this splint is that it does not give quite enough support to the limb. Prof. Volkmann's (based on that of Prof. Nathan Smith for the lower extremity), Prof. Esmarch's (Fig. 65), and Prof. Ollier's, all of wire and easily bent, are better in this respect, and all admit of the limb being slung—a great relief to many patients during the first week or so, this position also readily showing whether any discharge has made its way through the dressing. If plaster-of-Paris bandages are used to secure the splint, they should be left off as soon as possible owing to their cramping effect upon the muscles. Wooden splints should not be employed. They

* Mr. Heath thinks (*loc. supra cit.*) that "the ulnar nerve is more in danger of being cut with the saw when the ulna is divided than when the section of the humerus is made, it being more difficult to clear the former bone."

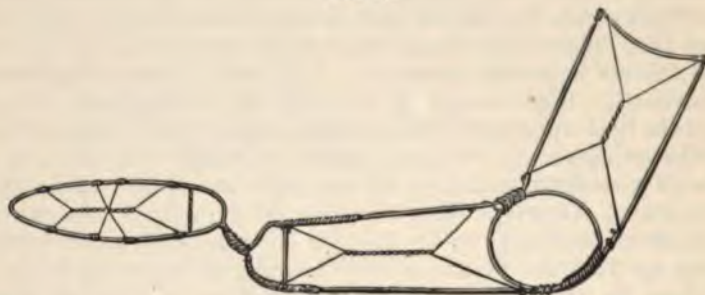
† Farabeuf (*Man. Opér.*, p. 710) points out that if, owing to long-existing disease of the elbow, the shoulder, wrist, or fingers are stiff, opportunity should now be taken to break down adhesions.

‡ By some surgeons a splint is here dispensed with. I strongly advise the use of one which is light and simple (*vide supra*), especially in children, as, during the first two weeks, where a splint has been dispensed with, the bone ends have been known to project from the wound.

are not easily sterilised, they do not admit of alteration of the position and angle of the joint, and anterior angular splints are always dangerous in children owing to the delicacy of the tissues on which the splint exerts most pressure (p. 65).

Passive movement of the fingers and wrist should be begun on the second or third day. The joint itself should be moved as soon (but very gently and slightly) as all irritation has entirely subsided and the deeper part of the wound is firmly healed—about the twenty-first day; this date varying according to the size of the gap left between the sawn bones, the probable condition of the tissues as to inflammatory exudation, &c. In children an anæsthetic may have to be given several times. The angle of the splint should be altered or the limb put up straight for a few days, and then flexed. Later on, weight-extension should be used, by securing a bag of shot, which is added to from day

FIG. 65.



Esmarch's wire splint for excision of left elbow. The supine position of the hand, which it is important to preserve, is well maintained in this splint. Plaster-of-Paris bandages may be used. The splint should be bent to an acute angle. (Mac Cormac.)

to day. A better method, especially with children, because it is gradual and gentle, and one that can be made interesting to them, is the old-fashioned one of weight and pulley. The patient is seated with the elbow resting near the edge of a table. To a pulley overhead a rope carrying a weight is attached. The patient grasps the free edge of the rope with the hand on the sound side, while with the other he holds the rope a little above the weight. The rope is now pulled upon with the hand on the sound side; this flexes the joint, and when the pull is relaxed the limb is extended. This should be practised assiduously until half an hour a time two or three times a day is attained. To be of use, this method must be begun early. The elbow must be kept firmly on the table, or the movements will be made at the shoulder-joint. Later, the sound limb may be fastened up, so that the child must use the excised joint. But when these aids have to be resorted to, the result will often be imperfect. The surgeon should put himself on the safe side by ensuring, originally, a sufficient gap between the bone ends when he uses the saw.* The best test of the future usefulness

* Mr. Whitehead (*Brit. Med. Journ.*, 1872, vol. ii. p. 554) records the case of an adult in which $2\frac{1}{2}$ inches of the shaft of the humerus had to be removed after sawing off the

of the limb is that the first passive movements are free and almost painless. The getting children to use the joint is often most difficult, as friends are usually too foolish to see that the surgeon's directions are carried out daily, because they cause a little brief, but most necessary, suffering. Parents are far too ready to think that because an operation has been performed, and the wound nearly, if not quite, healed, no more is necessary.* In commencing pronation and supination early, the ulna should be steadied while the hand and radius are very carefully moved. The first attempts at passive movement should be exceedingly gentle, and too much should not be attempted at first. I am aware that the date above given for the commencement of passive movement is later than that often taught—*e.g.*, about the tenth day. Nothing will be lost, but much gained, by giving the parts the longer rest. If the surgeon pictures to himself what is going on under the skin he will recognise that every time early passive movements are practised, the uniting structures, as yet richly cellular with vessels of embryonic tissue, are injured, and fresh exudation and hæmorrhage follows, which must all be absorbed or organised. When the parts are sufficiently firm, the splint may be left off and a sling substituted. Falls must be carefully avoided, and no liberties taken with the new union—*i.e.*, by a patient attempting to do too much with the limb, as in lifting. Later on, when an increasing range of movements may be allowed, resort to a gymnasium will be very beneficial.† Finally, it is always to be remembered that a twelvemonth must elapse before the full benefits of the operation—*viz.*, a complete combination of mobility and stability—are gained.

TEST OF SUCCESS.—In about four months from the operation the patient should be able to move the new joint freely and efficiently, to dress and feed himself easily, and to lift fairly heavy weights. But it will be nine months or a year before the joint is thoroughly firm and strong.

REPEATED EXCISION.—I have tried this in three cases, two of them instances of obstinate pulpy disease; in each a very useful but much shortened limb resulted. In the third, partial excision had been performed at a provincial hospital for an injury to the lower epiphysis of the humerus in a boy of 14. Great pains had been taken, but the limb was almost completely stiff and at an obtuse angle. After re-excising the joint completely, I secured a useful angle, admitting of the hand being brought to the mouth, placed behind the back, &c., so that the boy could feed and dress himself. The movements of the joint ultimately remained much restricted owing to the absolute apathy

condyles. The patient was the subject of tertiary syphilis, and the operation was performed three years after an injury to the elbow. The joint is stated to have been completely disorganised. Nine months later she was able to follow her occupation as charwoman with full use of the joint.

* Pronation and supination in a child are often only apparent, the forearm and arm being rotated together from the shoulder.

† In some cases the regain of only a limited amount of movement is unavoidable—*e.g.*, where an injury to the elbow-joint requiring excision co-exists with a fracture of the humerus necessitating absolute rest of the limb. Here the bone ends must be removed very freely.

and indifference of the patient. While opening up the old wound and again separating the bone ends gives excellent access to the remaining disease, this step will be but seldom required if the rule is followed, after excision of such joints, to give ether repeatedly as soon as there is evidence of persistent disease, and slit up any sinuses or undermined tissues, thoroughly use sharp spoons, and, if needful, pack in, for a few hours, strips of iodoform gauze wrung out of an emulsion of glycerine and iodoform or sulphur. (See the remarks made on this subject under "Excision of the Wrist and Knee.") Where, in cases of failed excision, the tubercular mischief has burrowed out amongst the muscles, where osteitis and osteo-myelitis are also present, amputation is to be preferred, especially if the general condition of the patient is not satisfactory. In flail-like union, where the limb remains quite useless in spite of the employment of a leather support* (which it very rarely does), where the muscles are not helplessly wasted, and no neuralgia is present, re-excision should be tried in preference to amputation, and a trial may be made of uniting the bones with wire.

Other Methods.—I have described excision by a single posterior incision, because I consider that this method gives the best results in the largest number of cases, and is best suited to the majority of operators who will not perform this operation very frequently, and who should, therefore, strive to perfect themselves in one method. The above method is very simple; it affords, if freely made and efficiently aided by retractors, ample exposure of the joint; its limited interference with the triceps does not prevent the regain of complete extension. Therefore other methods will be very briefly given.

M. Ollier (*loc. supra cit.*, p. 200), while admitting that the single posterior incision allows of the fulfilment of the essential conditions of the subperiosteal method, considered it inferior to his method because it affords less facility for the different steps of the operation, gives less room, and is, besides, inferior as regards the after-treatment. A final and especial objection given is that this incision cannot serve as an exploratory one when the surgeon is uncertain whether he will perform a complete or partial resection. I cannot, with all due respect to the late Prof. Ollier, accept any of the first three objections as valid ones; and, with regard to partial resections, I have elsewhere (pp. 105 and 120) stated that my opinion of them is a very unfavourable one.

Ollier's Method by a Bayonet-shaped Incision.—This method, though generally preferred by the above well-known Lyons surgeon, was introduced by him especially for cases in which ankylosis, which could not be broken down, was present in an extended position. An incision, vertical at first, made above, over the external supra-condyloid ridge, sinking between the triceps and supinator longus from a point $2\frac{1}{2}$ inches above the level of the joint to the top of the external condyle, and passing vertically down over this; the incision then passes obliquely across the olecranon between the outer head of the triceps and anconeus, and below descends, vertically again, upon the posterior border of the ulna for 2 inches. Through this, the main incision, the external condyle, head of radius, and olecranon are dealt with. To expose the inner condyle, make sure of the ulnar nerve, and to detach the soft parts and lateral ligament, a second small incision, about 2 inches long, is made internal to the ulnar nerve and parallel with the inner border of

* See the case mentioned below (footnote, p. 122).

the humerus. The incision is at first a superficial one. As it is carefully deepened, the above-mentioned intermuscular planes are identified, and along these planes the bones and joint are reached, by division of the periosteum and capsule. The operation is completed on the lines already given. The following appear to me to be objections to the above method. In the first place, ankylosis in the extended position is a rare condition, and the union in this or any ankylosed portion of the joint which cannot be safely * broken down under an anæsthetic can be divided, after the back of the joint has been thoroughly exposed by a single vertical incision, by an osteotome or narrow-bladed saw, and the operation completed in the usual way. I have not found that this step "exposes the neighbouring parts to great risk of injury" (Mac Cormac). Further, the central or oblique part of the incision must surely divide the very important outer expansion of the triceps. Finally, while the main incision exposes fully the parts about the external condyle, the small internal one, while introducing a complication, would be inadequate, with most operators, for the separation of parts on the inner side of the wound.

Method by Two Lateral Incisions.—Both Ollier and Hueter have employed this method largely, especially advocating it in cases of ankylosis. By a small ulnar incision, made vertically, about an inch long, slightly to the front of the internal condyle, the attachment of the flexor muscles and the internal lateral ligament are detached. By a radial incision, 4 inches long, with its centre over the external condyle, the structures on the outer side are next dealt with. The bone ends may be removed by a narrow saw. It is claimed that this method interferes less with the triceps than that by a single posterior incision, and this is no doubt correct. It is well known, however, that after the latter method complete extension may often be regained. Whether the second chief advantage claimed for this method is correct—viz., that the ulnar nerve does not come into view, and is placed beyond the reach of injury—is, I think, considering the amount that has to be done through a very limited incision, much more doubtful. If lateral incisions are employed I should prefer two freer ones, of $3\frac{1}{2}$ or 4 inches long, and to recognise and draw aside the ulnar nerve. Such incisions have been employed by Dr. Stimson, of New York, in the treatment of old unreduced dislocations (*Trans. Amer. Surg. Assoc.*, vol. ix. p. 462). This method has been adopted, as preferable to others, by Messrs. Watson Cheyne, C.B., and Burghard (*loc. supra cit.*) both for erosion and excision of the elbow-joint. It is referred to above (p. 114), and will be described later, under the head of "Erosion," p. 123.

Excision in Cases of Gunshot Wounds.—The following points are brought out by Dr. Otis as the results of this operation in the great Civil War of America (*Med. and Surg. History of the War of the Rebellion*, pt. ii. pp. 845 *et seq.*). Compared with excision of the shoulder, the results were less brilliant. The cases are divided into the following groups:—I. *Primary Excisions*.—250 cases, with a death-rate of 21·3 per cent.: 27 of the 250 were ultimately amputated. II. *Intermediate Excisions*, i.e., during the period of inflammation, three to four weeks.—197 cases, with a death-rate of 35·2 per cent., nearly 14 per cent. greater than that of primary excision: 19 were submitted to amputation later on; 62, or nearly half of the cases, were reported to have complete ankylosis.† III. *Secondary Excisions*, thirty days or more after the injury.—54 cases, with a mortality of 9 per cent.

Period of Election.—Dr. Otis, after remarking that this has hitherto been unsettled, states: "I believe that the evidence, when fully analysed, will demonstrate that this resection conforms to the general rule in shot-fractures of the limbs, that primary operations are preferable whenever it is certain that recourse must eventually be had to operative interference." In the future, "intermediate" excision with strict antiseptic precautions and efficient drainage will, probably, be no more dangerous than "primary." The frequency of a flail-joint after "primary" excisions is due (α) to the large amount of bone often removed, (β) to the small reparative power of the periosteum uninflamed at this stage, (γ) to the often necessarily inefficient after-treatment. Sir W. Mac Cormac

* In young subjects, where the ankylosis has lasted long and the bones are atrophied, undue force may break one or more of the bones or injure one or more of the epiphyses above or below the line of ankylosis, instead of loosening this.

† Thus, if patients escape the risks of operations on inflamed soft parts, bones, &c. (p. 104), the ultimate result may be a fixed joint.

wrote (*Surg. Oper.*, pt. ii. p. 380): "In military surgery most authorities agree that the danger to life is less after a primary resection, but the functional results are not so good, and primary resection is, as a rule, impracticable in the field." In some of the above cases removal of detached fragments seems all that was done. This incomplete operation does not appear to be more successful in military than in civil surgery. As pointed out by Prof. Esmarch, free division of the capsule of the joint deprives the wound of much of its danger.

With regard to the results of this operation in the Franco-German war, Dr. Otis (p. 904) says that the average results met with by the Prussian surgeons are not discouraging, but the results reported by the surgeons attached to the French army of that day are "simply appalling." Dominick has tabulated 263 cases in which the results were accurately noted after the Franco-German war: in 28 cases (10.6 per cent.) there was good active motion, and a more or less useful hand; in 129 cases (49 per cent.) ankylosis took place, in 31 with a useless hand; in 24 cases there was an "active" flail, with a more or less useful hand; in 41 cases a "passive" flail-joint, with a useless extremity.

Mr. G. H. Makins, C.B. (*Surgical Experiences in S. Africa*, 1899—1900, p. 236) does not mention any case in which excision of the elbow-joint was performed. He writes "Injuries to this joint* came second in frequency in my experience to those of the knee. They were, in fact, comparatively common, especially in conjunction with fractures of the various bony prominences surrounding the articulation. Fractures of the lower end of the humerus were of worse prognostic significance than those of the ulna, on account of the greater tendency to splintering of the bone. I saw several cases of pure perforation of the olecranon without any signs of implication of the elbow-joint. Several cases of suppuration which came under my notice did well. I saw one of them, six months after the injury, with perfect movement" (*vide infra*, p. 154).

PARTIAL EXCISION.—The value of this has been disputed. I have already (p. 105) expressed myself as unfavourable to it. I have had opportunities of watching three cases which came under my observation with removal of the condyles in the one and the olecranon process in the two others. A most unsatisfactory amount of stiffness persisted. In cases of disease I should never recommend it, as it is likely to be followed by imperfect removal of the parts affected as well as by ankylosis.† So, too, this step should be rejected in cases of ankylosis.‡ In excision for injury it would be permissible to leave the articular ends of the bones of the forearm untouched when it had been needful to remove the end of the humerus very freely. In such cases careful passive and active movements would be additionally called for. The only cases in which partial excision of the elbow-joint would recommend itself to me are such instances as the case of excision of the head of the radius and lower end of the humerus related at p. 126, and the more

* Apparently all the injuries were from bullet and not shell.

† In support of the above opinion I would refer my readers to the following case, under the care, be it noted, of a surgeon with scarcely rivalled operative experience—Billroth (*Clin. Surg.*, p. 370). "In a well-nourished child, æt. 14, who had had disease of the elbow for six years, originating without known cause, I partially excised the joint, *i.e.*, removed only the carious portions of the trochlea and the olecranon, together with a small part of the condyle of the humerus. The parts healed up, but complete ankylosis followed. This was forcibly broken down under anæsthetics, but considerable reaction invariably followed, and the ankylosis returned as before. I then resected the joint again, removing the end of the humerus subperiosteally, with a satisfactory result."

‡ Sir W. Mac Cormac pointed out that in these cases to excise the end of the humerus alone will not permit of pronation or supination afterwards, as the radius and ulna are soldered together at their upper ends.

common one, excision of the fractured internal epicondyle or epitrochlea. Removal of this process will be especially indicated when it is made out, at once or later on, to be the cause of limited movement in the elbow-joint, or when it is the cause of pressure upon the ulnar nerve.* Cases in which the epicondyle has been successfully removed for the latter reason will be found recorded by Mr. J. Hutchinson, jun. (*Brit. Med. Journ.*, vol. i. 1892, p. 113), and Mr. Poland (*Traumatic Separation of the Epiphyses*, p. 355), this latter surgeon giving several cases besides his own. I may remind my readers that in some of these cases

FIG. 66.



Periosteal elevator and other instruments of very useful pattern for excision of joints. (Farabeuf.)†

of fractured internal epicondyle the joint is opened and serious ankylosis will follow expectant treatment. Further, that in many of the recorded cases of separation of the internal epicondyle, the joint having apparently escaped, the amount of ankylosis which follows is quite out of proportion to the slight amount of injury (Malgaigne, quoted by Poland, *loc. supra cit.*, p. 376). In such cases more than a partial excision will be required. Dr. G. E. Davies, of Philadelphia, advises *osteotomy of the humerus for cubitus varus*, the deformity which may follow a fracture of the internal condyle not corrected at the time of the accident. He looks upon this as the most common of fractures about the elbow-joint. *Technique*.—An incision is made over the

* The nerve lies in a groove at the back of the process, being held in place also by fibres which pass from the epicondyle to the olecranon, giving attachment to part of the flexor carpi ulnaris.

† They can be obtained at Hawksley's, 357, Oxford Street; also from Down Bros.

internal condyle and prolonged upwards, and the bone exposed by careful dissection. The brachial artery and the median nerve lie to the outer side and in front of, the ulnar nerve to the inner side and behind this incision. The edges of the wound having been well retracted, a narrow osteotome is introduced and the bone divided, but not completely. The remainder is then fractured or bent until the desired position is attained. The limb is kept extended in plaster of Paris for six weeks; after removal of this, massage and movement restore the mobility of the joint in two weeks. Three cases are given with successful results (*Annals of Surgery*, Jan. 1899).

Unfavourable Results of Elbow-Joint Excision.

1. Persistence of tuberculous disease. This is especially likely when, previous to the operation, the capsule has been perforated and disease has burrowed out amongst the origins of the flexors or extensors. 2. Caries and chronic osteo-myelitis. These are not unlikely to supervene when the reparative power is poor and the wound becomes infected. 3. Ankylosis. This is not uncommon in children, owing to the great tendency of inflammatory products to organise quickly in early life. Furthermore, there is the difficulty of getting them to use the joint or submit to passive movement; all they will do is to move their arm and forearm from the shoulder-joint (p. 117). But thorough persevering treatment will secure a sound though stiff joint, with a very useful hand. 4. A flail-like joint.* A limb may remain weak for some time, owing to the muscles not taking on firm attachments. Friction and galvanism should be used perseveringly. If there is too much separation between the ends, the patient should wear a well-moulded support; the use of the hand and fingers will thus be retained, and, if the patient is young, gradual and great improvement will very likely take place in the elbow. Re-excision and wiring may be tried in some cases with healthy patients. According to Sir W. Mac Cormac (*loc. supra cit.*, p. 398) most of the flail-joints follow the extensive removal of the lower end of the humerus, especially in cases of injury. In such cases the periosteum of the condyles and the muscular attachments should be as little interfered with as possible. He pointed out that flail-joints are of two kinds:—(1) Active flail-joints, in which the muscles are strong and exercise control. These may be very useful, especially when aided by a support to the elbow. (2) Passive flail-joints, where the muscles are wasted, and the hand only can be used by the employment of a supporting splint. 5. If the wound becomes infected; cellulitis, erysipelas, &c. 6. Secondary hæmorrhage. This occurred in 11 out of 250 military cases (Otis, *loc. cit.*, p. 860). 7. A useless limb, owing to the muscles being utterly wasted from long disease and disuse. 8. Injury to the ulnar nerve with its resulting interference with motion, sensation, and nutrition. A few days after the excision the nerve should be found by a second incision below and in front, traced upwards and united. 9. An adherent scar.

* Mr. C. Forster (*Lancet*, 1872, vol. i. p. 3) related a case in which the right limb was a perfect flail, yet with the help of a leather moulded splint all the movements of the fingers were good, and the patient could do needlework and write well. Such a splint is capped to the shoulder and moulded to the limb down to the wrist, leaving the fingers free, and strapped round the chest.

ERASION OF THE ELBOW-JOINT.

This operation has not been extensively practised, partly on account of the good results given by a carefully performed excision, and partly because this joint does not lend itself to free exposure by so simple an incision as in the case of the knee-joint. The statement of some surgeons that in children, at the present day, excision of joints for tuberculous disease is quite unnecessary, as erosion is perfectly satisfactory, requires qualification. Whatever be the joint, erosion can only be perfectly satisfactory if performed in suitable, *i.e.*, early, cases. Where the bones themselves are not diseased, erosion will give better results than excision; but tuberculous disease of the joints, and among them the elbow, does not always come before the surgeon in its early stage.

Mr. Clutton, at a meeting of the Medico-Chirurgical Society (*Brit. Med. Journ.*, Dec. 16, 1893), advocated early erosion of the elbow-joint in place of late excision. He exposed the joint by dividing the olecranon. Nine cases were thus treated. Of these the first two had ankylosed joints, but very serviceable limbs. Six cases resulted in more or less movement in the joint, with cessation of the disease. The ninth and last case was subsequently excised.

While I would, first, allow that I have no personal experience of erosion of the elbow-joint, I am very doubtful if this operation will give results equal to those of a well-performed excision. In experienced hands erosion will usually remove all the disease, but here we want a movable, and a freely movable, joint as well. Judging from Mr. Clutton's cases, I doubt if the latter will be obtained if erosion of this joint comes into vogue on a large scale. And, speaking from an experience of some forty cases of erosion of the knee, I think, after erosion, there must be a tendency to fibrous ankylosis between the ends of the bones which are left. Now, this is not a matter of much importance in the lower extremity, where a firm support, as little shortened as possible, is the chief point to be attained. In the case of the elbow-joint, on the other hand, complete removal of the disease and free mobility are the height of our desires. The latter certainly—and, I believe, the former also with the majority of operators—will be best attained by excision with free removal of the ends of the bones (p. 114). Next to thorough exposure and complete removal of the disease, a freely movable joint is what we require here, and, if this be attained, it matters very little if the limb is shortened.

Erosion of the Elbow-Joint.—The following account, owing to my want of experience of this operation here, is taken from the *Manual of Surgical Treatment*, pt. ii. p. 260, by Messrs. Watson Cheyne, C.B., and Burghard. It will be noticed that these writers speak guardedly of the amount of movement which may be expected afterwards. "In children the operation will be arthrectomy. Arthrectomy in children is an extremely satisfactory operation, which generally leaves a certain amount of movement, although the restoration of function is not complete. The operation is best performed through two long lateral incisions, one on either side of the joint. On the inner side, the incision should reach from just below the point at which the ulnar nerve pierces the internal intermuscular septum downwards

to about 2 or 3 inches below the level of the joint. On the outer side, the incision may extend slightly higher up the arm, but must not reach as low down on the forearm for fear of injuring the posterior interosseous nerve just opposite the neck of the radius. It is well to make the incisions as free as possible because plenty of room is required to enable the surgeon to see clearly what he is doing. The incisions are carried down to the condyles of the humerus, and the removal of the synovial membrane from the back of the joint is proceeded with. The capsule can usually be readily defined especially upon the outer side, and the skin and subcutaneous tissues are raised from it by the handle of the knife or a blunt dissector. The whole of the capsule over the radio-ulnar and the radio-humeral articulations is thus gradually separated as far as the edge of the olecranon. The triceps is also raised from the capsule as far as the middle line of the joint, when a similar procedure is adopted on the inner side, care being taken to raise the ulnar nerve from its groove behind the internal condyle along with the soft parts and not to injure it. The fingers can then be made to meet across between the triceps and the capsule, and thus the whole of the upper part of the synovial membrane is easily separated and can be divided by a knife just at its reflection on to the bone, and peeled carefully downwards; it is also divided on each side in the line of the incisions, and is cut away below at its attachments to the olecranon, and to the radius and ulna. The entire posterior portion of the synovial membrane is thus removed, and the next step is to deal with the anterior portion. In order to do this satisfactorily it is generally advisable to partially detach the tendinous origins of the muscles from the condyles of the humerus, beginning over the outer one. The periosteum is incised and stripped forwards, together with the muscles arising from it, with a periosteum-detacher; these structures are pulled forcibly forwards, an assistant holds the limb flexed to a right angle, and the anterior surface of the capsule is defined and separated by a blunt dissector and the fingers. Special care must be taken not to damage the posterior interosseous nerve in the lower part of the incision. The structures on the inner side are then dealt with in a similar manner, the periosteum and the tendinous origins of the muscles being separated from the internal epicondyle and the capsule defined and separated from them. The finger can soon be made to pass across from one incision to the other between the capsule and the superficial structures, amongst which will be the brachial artery. By passing the finger upwards and downwards the entire front portion of the capsule can be separated and may be cut across at its attachment to the bones, and removed whole. The lateral ligaments are divided in doing this, and the ends of the bones can then be easily protruded through the wound; the olecranon is first pushed through whichever incision it can be made to project from more easily—generally the outer—and the synovial membrane of the radio-ulnar articulation is completely removed. The orbicular ligament will also require careful inspection for it is often diseased. After all the synovial membrane has been removed from its attachment to the bone, and after any portions of cartilage or bone that are affected have been shaved off with a knife or freely gouged out, the humerus is protruded through one of the wounds—generally the

inner—and examined. Special attention must be paid to the olecranon and coronoid fossæ, and the articular surface must be treated in a manner similar to that adopted for the bones of the forearm. After the disease has been thoroughly removed, the bones are replaced, the wounds stitched up without a drainage tube, the usual antiseptic dressings applied, and the limb placed upon an internal angular splint. Should septic sinuses be present, they must be treated by excision if possible, or at any rate by thorough scraping, the articular surfaces should then be sponged over with undiluted carbolic acid, and a drainage tube inserted when the wound is sewn up; when no sinuses are present, drainage is seldom, if ever, necessary. *After-treatment.*—The splints should be retained for three or four weeks, after which the arm should be kept in a sling for another two or three weeks, and the patient encouraged to move it freely. There is no particular advantage in performing passive movement; in a child, the arm will be constantly used, and the result will be as good by leaving the case to nature as by trying to force it with passive movement. The only form of passive movement that is really desirable is rotation of the hand, and this may be practised diligently, both actively and passively."

EXCISION OF THE SUPERIOR RADIO-ULNAR JOINT.

Indications.—This operation may be, very occasionally, made use of, with every precaution, in old cases of dislocation of the head of the radius, where reduction has not been effected owing to the amount of swelling, &c., and where the movements of the forearm are much hampered, especially in a young and healthy adult.

Operation.—An incision about 2 inches long is made over the projecting head of the bone behind or through the posterior part of the supinator longus. The soft parts having been separated with a blunt dissector and held aside with retractors, the neck of the radius is carefully divided with a fine saw or cutting bone-forceps. Sufficient bone must be removed here or from the external condyle to leave a gap that will avoid the risk of fresh ankylosis. The musculo-spiral nerve lies to the inner side, and great care must be taken not to interfere with this or the biceps tendon. The forearm should be put through its movements (p. 114) freely but carefully, while the patient is under the anæsthetic, so as to break down adhesions. Any needful drainage should be provided, and every care taken, by not interfering with the soft parts more than is absolutely needful, and by keeping the wound aseptic, to secure primary union, and thus avoid the risk of stiffness again occurring. After a few days a sling may be substituted for a splint, and, ten to fourteen days later (p. 117), passive movements made use of daily, with the aid of an anæsthetic if needful.

In October 1894 I excised the head of the radius in the following obscure and instructive case:

In the previous August the lad, aged 12, had fallen from a ladder partly on to his feet, partly on his right elbow, not on the hand. Much swelling of the joint had followed, with subsequent stiffness, rendering the limb very useless. Passive movement had been tried, but the patient had done his best to render the result negative. The forearm was fixed in a position midway between pronation and supination, and flexed at a right angle.

No flexion was possible beyond this. Passive extension to about 120° . Pronation and supination, passive and active, quite abolished. A prominence—? the head of the radius—to be felt below the external condyle, but not admitting of rotation; there was no crepitus. Dr. Harsant, of Bristol, sent me the case as one probably of dislocation of the head of the radius, and with this view I agreed, though against it were the history of direct violence and the absence of any rotation in the swelling. On exploration of the injury by a free lateral incision, it turned out to be one of those rare cases of fracture through the neck of the radius. Just below the external condyle the head of the radius was found separated from the shaft by a fracture through the upper part of the neck, and lying with its articular surface turned directly outwards. On removal of this there was distinct improvement in pronation, but little in supination. Flexion was now possible to 40° , and extension to almost the complete range, but only on forcible movement. As the movements were still incomplete, and certainly would not be retained, I removed the capitellum of the humerus from the same incision with a narrow osteotome. The forearm could now be put through its full range of movements. The wound healed under an aseptic clot, and the patient, when he left my care five weeks later, had recovered almost complete active movements of the joint, though the whole limb was still weak. Three months later I heard that he could "do everything nearly as before the accident, and that he could also carry considerable weights."

Mr. Wainwright (*Clin. Soc. Trans.*, vol. xix. p. 332) records a somewhat analogous case, in which, in an adult, he removed the head of the radius, which was vertically fractured, and the coronoid process, which had been imperfectly united with fibrous tissue. The accident had taken place three months before. The movements of the limb were distinctly improved by the operation.

UNUNITED FRACTURE OF THE OLECRANON.

Indications.—For some further details the reader is referred to the remarks on treatment of ununited patella by wiring. *A. Simple Fracture.*—(1) Operation should be the rule *directly after the injury*, under favourable surroundings, in a healthy patient to whom the unimpaired movements of the limb are of the first importance. And the indication for operation here will be greater if there be much lateral tearing of the joint-capsule, as shown by distension and bulging. (2) Where, in spite of careful treatment, the limb is weak and its usefulness seriously interfered with, especially where the occupation of the patient requires vigorous extension of the elbow.* (3) Where such treatment has not been used, but the time for it has gone by. In either case the patient should be young and healthy. His future life and the surroundings under which this will be spent must also be taken into account. The object of the operation, its possible risks and the need of his full and intelligent co-operation should be fully explained to him. It is well for another patient who has had the operation performed, to meet him. Moreover the patient should realise that a union, however close and useful it may be at first after a judicious employment of splints, will not remain so if submitted to constant and laborious work. Another clear but rare indication for wiring is when both olecrana have been fractured, or when a patient, in addition to a fracture of one olecranon, has a fracture anywhere in the opposite upper extremity, thus rendering him very helpless. I may here make a suggestion to my juniors.

* The surgeon will examine how far this power is lost, to what extent the triceps has wasted, and what evidence of union there is between the fragments.

Where, for any reason, operation is not performed, there should be no time wasted with troublesome splints, difficult and usually futile attempts to draw down the upper fragment with strapping, &c., but the case should be assiduously treated from the first with well applied massage. If this be intelligently carried out, the wasting of the triceps and other muscles does not take place, the effused products are quickly absorbed, and the adhesions in and about the joint are prevented. The patient carries his arm in a sling, and begins to use it cautiously. The result is excellent with far less irksomeness to the patient, and trouble on the part of the surgeon. B. *Compound Fracture*.—Here the operation is distinctly indicated in competent hands. The free incision required will relieve the tension of the ecchymosed soft parts, it will aid the needed asepsis, it will admit of the removal of any detached fragments, it will enable the surgeon to empty the joint of clot, which, even if it do not suppurate, will persist tediously and impair future movements. Finally, it is taken for granted that a surgeon undertaking this operation has good reason for feeling confident in his knowledge of modern surgery.

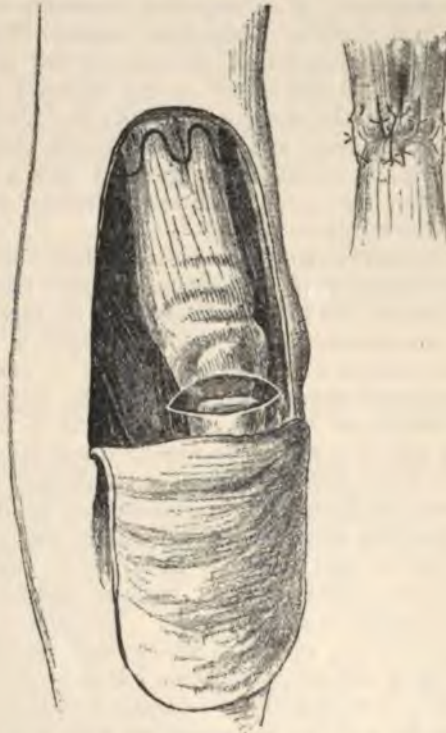
Operation.—The parts having been most carefully* cleaned before and again at the time of the operation, the surgeon raises a convex flap of skin, subcutaneous tissue and the olecranon bursa. In most cases the convexity should be downwards. The incision begins a little above the level of the fracture, about 1 inch to one side of it, and is then carried downwards, and curved across the back of the elbow about 1 inch below the lower margin of the olecranon, and then finally carried up upon the opposite side to a point opposite to where it began. In those old standing cases where there is reason to think that the triceps must be elongated in order to bring the fragments into position (*vide infra*), the convexity of the flap must be carried sufficiently upwards so as to expose the lower part of that muscle. In any case, care must be taken to raise a flap of even thickness and uniform nutrition throughout; when raised it is wrapped in sterile gauze. The line of fracture is then made out,† any torn edges of fascia which may lie between the fragments are turned aside and trimmed clean, but not removed; the joint is fully flexed, and any clots picked out or washed away with sterile saline solution. The surfaces of the fragments are then refreshed, if needful, with a fine sharp saw or chisel. And before this is done it may be needful to remove some adhesions between the upper fragment and the humerus. To carry out the wiring, a small incision is made vertically down to the ulna, a full $\frac{1}{2}$ inch below the line of fracture. Where the

* The area of the wound must be, previously, widely shaved, and then thoroughly soaped and scrubbed. The skin is next disinfected (1) by turpentine, or, as I prefer, liquor potassæ in dirty skins at the time of operation, (2) by soaking it for a few minutes with a solution of biniodide of mercury and methylated spirit (1 in 500); (3) this is washed away with a watery solution of biniodide of mercury (1 in 2000); (4) an antiseptic dressing—*e.g.*, iodoform gauze soaked in and well wrung out of the above watery solution of the biniodide, or a 2 per cent. lysol solution, and over this salicylic wool—is well bandaged on till the operation.

† This may be at one of three places, (a) The tip of the olecranon may be broken off; (b) the olecranon may be broken at about its centre, where the greater sigmoid cavity narrows; (c) this process may be detached at its junction with the shaft of the ulna. In my experience, this is the commonest.

bone may be fatty, as after disuse, drilling nearer to the fracture will certainly lead to the wire cutting through when tightened up. The cut edges of the periosteum are at once seized with Spencer Wells' forceps, to mark the spot and to obviate one difficulty in passing the wire. The bone is then drilled obliquely with an ordinary sterilised bradawl—several sizes should be at hand—the point emerging on the fracture surface just above the articular cartilage. To ensure accurate

FIG. 67.



Method of lengthening the triceps in the operation for wiring long-standing cases of fracture of the olecranon. The larger figure shows the long flap required for exposure of the triceps, and the serrated division of the muscle described in the text. The smaller figure shows the method of approximating the serrations above and below, and how the muscle is elongated. The apices of the serrations are made blunt in order to secure a larger surface for union (Cheyne and Burghard).

symmetry in drilling the second fragment the two are brought together and, the bradawl being withdrawn, a second vertical incision is made with the same precautions over the upper fragment, and its edges seized with forceps. The bradawl is then again introduced obliquely so as to secure a passage for the wire precisely opposite to the first. Sterilised silver wire* is then insinuated through the openings in the fragments,

* Lord Lister (*Lancet*, 1883, vol. ii, p. 761) gives wire about $\frac{1}{16}$ inch as amply sufficient for the olecranon, while for the shaft of the femur, in an adult male, a piece of wire

and the forceps which act as guides to the apertures are not removed till this is done. Flexion of the joint to the full facilitates passage of the wire. The joint is now finally cleansed, the forearm is extended, and an assistant, with a piece of sterilised gauze in each hand, brings the fragments accurately together. The surgeon, grasping the ends of the wire in Spencer Wells' forceps, straightens them, and keeping his hands low makes a small, neat twist of about two half-turns. The ends, cut short, are next hammered down into the periosteum and bone. The handle of a metal gouge will serve if a small hammer is not at hand. The ends should be completely buried by drawing over them any fascia or periosteum, whichever is at hand. This and any lateral gaps in the capsule are carefully drawn together with fine sterilised silk. The flap is then sutured with sterilised horsehair. As a rule no drainage will be required. In a few cases, where from great ecchymosis, superficial and deep—and it will be remembered that these fractures are usually due to direct violence, and that some patients fall very heavily—there is risk of sloughing and consequent infection, a small drainage-tube should be employed, and the wound sutured with fine sterilised salmon-gut, and only some of these drawn close at the time of the operation. If an ample dressing is applied the limb may be placed in a sling and bandaged to the side with the joint flexed, no splint being needed in most cases. In some cases of secondary suture where there has been difficulty in getting the fragments together, the limb should be put up extended on a splint. In about ten days passive and active movements of the joint should be carefully begun, and continued with the persevering and intelligent co-operation of the patient, who should have been warned, beforehand, of the necessity of his undertaking a full share of the responsibility in the result.

Occasionally, in cases of secondary suture, it will be impossible to approximate the fragments without elongation of the triceps. The best way of doing this is that given by Messrs. Watson Cheyne, C.B., and Burghard (*Manual Surg. Treat.*, pt. iii. p. 88). "If the muscle be divided transversely the upper fibres will contract, and a gap will be left in the muscle which may lead to much functional disability. The incision should therefore be V-shaped, or zigzag; two V's or serrations, with their apices upwards, carried through the breadth of the muscle are sufficient. It is done as follows: An incision commencing at the left edge of the triceps is carried obliquely upwards and to the right through the muscle for about 2 inches, according to the amount of shortening present; the termination of this incision should be distant from the left edge one quarter the entire breadth of the muscle. From this point a second incision is carried obliquely downwards and to the right, terminating in the centre of the muscle on a level with the starting point of the first. A third incision then runs obliquely upwards, and also to the right, terminating at the three-quarter point, and the division is completed by carrying another from this point obliquely downwards to the right again, and bringing it out to the right edge of the muscle. This gives a series of serrations above and below

about $\frac{1}{10}$ inch in thickness is requisite in order to resist with certainty the enormous force of the great muscles of the thigh; wire of about No. 13 English gauge is usually the right size for the olecranon.

the line of incision, and when the fragment with the tendon attached to it is pulled down the apices of the serrations should be in contact if the incision has been properly planned. The adjacent sides of the serrations above and below are stitched to each other, so that two blunt cones are formed, one above and the other below the line of division of the muscle; the apices of these blunt cones are then stitched together by the muscle sutures. The incision is best made in the lower part of the muscle, so that the apices of the upper serrations include some portion of the tendinous expansion; the best union is obtained if muscular fibres be included in the incisions instead of making them entirely through the tendon." (Fig. 67.)

DISPLACEMENT OF THE ULNAR NERVE.

This may come on at an early date after the strain, or at a much later period, being then due to obliteration of the groove in which the nerve lies with fibrous tissue, or, perhaps, from irregularity of the growth of the lower epiphysis. Mouchet (*Gaz. des Hôpitaux*, 1902, vol. lxxxv.) has shown that several years may elapse before the displaced nerve causes trouble. During this time the functions of the joint may have been very satisfactory. Dr. Farrar Cobb, of Boston (*Annals of Surgery*, Nov. 1903, p. 652), has shown by a list of cases that the operative treatment of this condition is simple and successful.

Operation.—An incision is made over the normal position of the nerve which may now lie very superficially. If its natural groove is present and merely empty—and this is usually the case—all that is needed is to replace the nerve, and to suture over it any fibrous tissue available. In other cases, a flap is taken from the fascia over the muscles attached to the inner condyle, and this is sutured to the periosteum over the olecranon; or the inner border of the triceps is attached to the periosteum over the inner condyle. The groove which the nerve should occupy is freed from any scar tissue which may have filled it up; and, if it be needful, the groove should be deepened with a gouge. If it is clear that the nerve is now securely fixed, the limb should be placed on an angular splint, and so retained for three weeks. If the security be at all doubtful, and if the displacement be of long duration, the limb should be kept in an extended position. The nerve is sometimes found to be thickened. When this is the case, and the pain persists after the operation, the existence of neuritis may explain it.

VENÆSECTION.

Indications.

1. Some cases of pneumonia after injury, as where a plethoric young farmer breaks several ribs when riding, and acute pneumonia sets in and extends rapidly.—Here the cyanosis, orthopnoea, the distressing pain, may all be relieved by a bleeding of eight to ten ounces, which very likely will have to be repeated.

In other cases of acute pneumonia which are not traumatic, bleeding may occasionally be resorted to with great advantage when the patient is young and of full habit, the breathing much oppressed, and the heart's action becoming embarrassed. Owing to the tendency to cardiac failure in this disease, the decision here is a very critical and difficult one.

On this point I will quote from a very instructive paper by Dr. S. West (*Brit. Med. Journ.*, 1892, vol. ii. p. 992): "In the first place, it is generally agreed that no patient with pneumonia should be bled if it can be avoided; but, at the same time, conditions may arise in which

bleeding may be really the only means of saving life, the conditions being those already referred to, namely, rapidly increasing cyanosis and failure from over-distension of the right heart. Still, such cases are, at the most, rare. Bleeding in pneumonia, if unnecessary, must be harmful, for cardiac asthenia is one of the chief dangers, and the risk of it is increased by bleeding. A vicious circle is thus established, for cardiac failure may itself produce the very symptoms regarded as indications for the bleeding, which in its turn will increase the cardiac weakness which has caused the symptoms. The question must be decided largely by the condition of the left ventricle, and it is unnecessary to say how difficult this is to determine. When the left ventricle is weak and failing, bleeding can do no good; when it is strong, bleeding may save life. Thus in pneumonia bleeding becomes a critical measure. It may save life, but it may, if wrongly employed, take all chance of life away.*"

2. In some cases of chronic bronchitis.—The late Dr. Hare† drew this graphic picture of such a case :

A middle-aged man with chronic bronchitis and some congestion of the lungs has exposed himself to chill. "He is sitting in a chair (to lie down is impossible for him), his face is blue and sunken, his lips purple, the eyes suffused and staring . . . his chest heaving, and each short gasping inspiration followed by a long wheezing and moaning expiration; his lungs are full of moist, sonorous, and mucous rhonchi, scarcely a trace of vesicular murmur is to be heard, and he is pulseless. He looks to you beseechingly, and gasps out, in scarcely articulate words, that he is dying. This is but true. Now, the treatment for such a condition at the present day is to 'pour in stimulants' (though the patient can scarcely swallow). Brandy and water are given, and ammonia, and perhaps ether; then, if the patient lives long enough, mustard poultices are applied to the chest and the calves and feet, and the patient is fanned, and the patient dies. . . . Appearances have been saved, but not the patient's life. The fact is that here the danger lay in the right side of the heart being gorged with blood, so that it was impossible for its stretched and distended walls to contract and to propel forwards the thick and blackened blood. . . . Open one of these veins, which are, with every systole of the heart, tending to carry more and more blood to this already distended right ventricle, and all may yet be well with your patient."

Captain F. J. W. Porter, R.A.M.C., relates a case (*Brit. Med. Journ.*, vol. i. 1901, p. 954) which illustrates the truth of the above remarks, and furnishes a valuable hint to military surgeons :

A lieutenant was shot through the chest in a Boer ambush. He was picked up four hours later, in a critical condition owing to dyspnoea from a large effusion of blood into the right pleura. Twenty-four hours later, while the patient was being taken across country to Heilbron, the lividity became so great and the pulse failed so much that 10 ounces of very dark blood were taken from the median basilic vein. The patient immediately turned on his wounded side and went to sleep. Next morning he was quite rational. Fifty miles were trekked in 28½ hours. The recovery was uninterrupted.

* Dr. Lucas Benham brought the advantages of Venæsection in Acute Pneumonia before the Medical Society (*Brit. Med. Journ.*, Oct. 29, 1898), but his advocacy of this step does not appear to have received much support.

† *Brit. Med. Journ.*, 1883, vol. i. p. 156; "Good remedies out of Fashion." Very interesting papers (with cases) will be found by Dr. Pye Smith (*Med.-Chir. Trans.*, vol. lxxiv. p. 147), Dr. Ogle and Sir S. Wilks (*Lancet*, vol. i. 1891, pp. 1029, 1139).

3. Where a tendency to apoplectic seizures exists.*—Dr. Hare (*loc. supra cit.*) thus wrote of this class of case. Nature speaks "in unmistakable language when by a copious epistaxis she efficiently relieves the congested turgid face,† the beating temples, the dull heavy headache, the sleepiness, the confusion of thought, and other symptoms, which in a plethoric individual betoken, if they are not relieved, serious danger, if not an apoplectic attack."

4. In aneurysms, especially thoracic.—As part of the treatment of Valsalva in a modified form. Formerly the bleedings in aneurysm were copious even to syncope. Nowadays they are made use of differently. They are small in amount, and are only repeated so far as to reduce excessive action of the heart, or to relieve certain symptoms (as they undoubtedly do), viz., dyspnoea and pain.

Dr. MacDougall, of Carlisle, in a most interesting paper (*Amer. Journ. Med. Sci.*, 1887, p. 38) points out the following as cases in which venæsection should be more often used when other means have failed. (1) Details are given of a case of mitral and aortic incompetence, with chronic Bright's disease and acute pleuro-pneumonia, in which recovery followed epistaxis to the amount of a pint. (2) Reaction after concussion, with a full, slow, labouring pulse, and headache. (3) In epilepsy in strong, big, healthy patients, venæsection will relieve the cerebral stasis. (4) In some cases of "croup," in late childhood, or in vigorous adolescents. (5) In acute pleurisy, with intolerable pain, unrelieved by morphia; where there is not much effusion, but lymph formation over a wide surface. (6) Very rarely in acute pneumonia, bilateral, in young healthy subjects, with a small pulse and strongly beating heart (*vide supra*). It is pointed out that the pyrexia here favours the dilatation of the right side of the heart. (7) In suffocative pulmonary catarrh with a trace of albumen and a few granular casts.† (8) In some cases of convulsions, *e.g.*, (a) after scarlatinal nephritis; (b) in parturient or pregnant women§—*i.e.*, in severe attacks, with extreme congestion, profound coma, and hard pulse; (c) in plethoric coma, preceded by headache, in full-blooded women about the time of the menopause.

To the above indications Dr. West (*loc. supra cit.*) adds the following:

In two cases the bleeding was performed early for cerebral symptoms of great gravity. One man, æt. 54, who had been seen to fall while walking, had fits affecting the left side

* This does not mean those cases where a rupture of a cerebral vessel has occurred, and where bleeding would interfere with that process of repair on which the patient's life depends.

† Dr. Copeman (*Brit. Med. Journ.*, 1879, vol. ii. p. 932) points out that in these cases, in addition to plethora and a full habit, evident distension of the superficial veins of the head and neck is a valuable indication that bleeding is proper.

‡ Dr. West (*loc. supra cit.*) gives two cases of sudden dyspnoea and cyanosis, associated in the one case with mitral disease and pulmonary infarcts, in the other with double aortic disease, in which venæsection to eight ounces and a pint respectively prolonged life, in the one case two days, and in the other three months, in comparative comfort.

§ Dr. Thomas, in advocating before the Border Counties Branch of the British Medical Association the use of venæsection in those cases of puerperal eclampsia where fits occurred previous to labour and where the administration of chloroform and immediate delivery by turning were impossible, evoked an instructive discussion from a body of men well qualified to give an opinion (*Brit. Med. Journ.*, vol. i. 1898, p. 400).

of the body, hand and forearm, then leg, neck and, lastly, the face. The pulse was 108, of high tension. There was no evidence of injury from the fall save a few scratches on the face. The lesion was diagnosed as a hæmorrhage either into the cortex or the pia mater, and the patient was thought to be dying. After the withdrawal of 30 ounces of blood the pulse fell, and the fits diminished in frequency, then ceased, and did not recur. Some paralysis of the limbs followed, but by the tenth day all power seemed to have been regained.

The second cerebral case was that of a man, æt. 42, who was suddenly seized with convulsions of the right side of the face and aphasia, the convulsions soon involving the whole of the right side, then becoming general, but being much more marked on the right than on the left side. As they became increasingly violent, with stertor, cyanosis, and complete unconsciousness, and as the patient was of a plethoric condition and his pulse of high tension, 40 ounces of blood were taken from the right arm. Ten minutes later, as the fits were recommencing, he was bled again to 25 ounces and faintness. The fits did not cease entirely until sixteen hours after their commencement, but they were shorter and less severe. The patient left the hospital well, but with diminished power of the right hand.

The following case reported by Mr. S. Paget (*Brit. Med. Journ.*, Oct. 5th, 1901) shows the value of venæsection in certain cases of fractured base with intracranial hæmorrhage, associated with a full pulse and high arterial tension.

A man was admitted, June 8th, with bleeding from ears and nose, and vomiting blood. June 9th, he was restless and trying to get out of bed; June 10th, temperature rose to 102°—104°. There was Cheyne Stoke's respiration, the face was deeply livid, and the pulse of high tension; 20 ounces of blood were taken from the median basilic vein; the temperature fell to 103°. June 11th, he was bled to 12 ounces; June 12th, temperature 100°—104°, the patient slept comfortably, and could talk intelligently; June 17, there was a discharge of cerebro-spinal fluid which continued till July 14th, when it ceased. The recovery was steady and complete.

Operation.—The skin having been cleansed (p. 127), the patient being usually in a sitting position, and a bandage tied round the middle of the arm with sufficient tightness to retard the venous circulation without arresting that in the arteries,* the surgeon selects the median cephalic or the median basilic, whichever is more prominent.† Steadying this vein by placing his left thumb upon it just below the point of intended puncture, and with his right hand resting steadily upon its ulnar margin, he opens the vein with a small, sharp scalpel, scrupulously clean, making with a gentle sweep of his wrist a small incision, and not a mere puncture, into the vein. The anterior wall of this being divided, the point, without penetrating any deeper, is thrust onwards, first increasing the slit in the vein, and then being brought out vertically, care being taken to make the skin wound larger than that in the vein. The thumb is now raised and the stream directed into the measuring-vessel.‡ While the blood is escaping, the limb should be kept in the same position, lest, by the skin slipping

* The surgeon makes use of the pulsation in the arteries to tell the relation of the brachial, or one of its branches given off abnormally high up and running superficially to the veins at the bend of the elbow (p. 151).

† If the patient is nervous, or if the veins are small, he should be told to hold a walking-stick or book. This steadies his arm, distracts his thoughts, and, by producing muscular contraction, supports and fills the veins.

‡ Not a drop of blood should be allowed to go on to the bed or the patient's linen.

over the wound in the vein, the blood should be prevented from escaping freely and thus make its way into the cellular tissue.

The required amount of blood having been withdrawn, a sterilised thumb is placed on the wound while the bandage is removed. A small pad of aseptic gauze is then placed on the puncture, and secured with a bandage applied in the figure of 8. This pad may be removed in about forty-eight hours, and for a day or two the patient should use a sling.

Difficulties during, and Complications after, Venæsection.

(1) Difficulty in finding a vein.—This may be due to their small size, the feebleness of the circulation, or the abundance of fat. If a vein cannot be made sufficiently distinct by hanging down the limb, putting it in warm water, flexing and extending the wrist and fingers, and chafing the limb, one should be opened on the back of the hand, or blood withdrawn from the external jugular or internal saphena at the ankle. (2) In other cases, where the patient is much emaciated, owing to the absence of steadying fat the mobility of a vein may enable it to avoid puncture, unless a very sharp instrument be used and the vein well steadied. (3) When the vein has been opened, sufficient blood may not escape owing to—(a) The opening may be a mere puncture. (b) The skin opening may be insufficient in size, or not parallel in position to that in the vein.—These impediments are removed by a freer use of the knife, carefully made, or by bringing the wound in the vein parallel with that in the skin. (c) A pellet of fat may block the opening in the vein.—This should be snipped away. (d) The patient may faint. (e) A thrombus may form. This will disappear when the venous current becomes more active. (f) The bandage may be tied too tightly round the arm. (4) Wound of the brachial or some other artery, *e.g.*, an abnormal ulnar.—This can always be avoided by a careful use of the scalpel, and by noting beforehand the existence of any pulsation. The force of the jet and the mixture of bright with dark blood will tell of this accident. Pressure should be carefully applied and maintained (p. 36), and blood taken from the opposite arm if required. (5) Escape of blood into the cellular tissue.—This will lead to ecchymosis, and perhaps formation of a thrombus, which may be absorbed, but which also may suppurate. (6) Phlebitis, or inflammation of the lymphatics.—These may be due to the use of infected instruments, aided by a low condition of the patient. They should be most carefully guarded against, as likely to lead to the following two most grave results: (7) Cellulitis and septicæmia. (8) Intense pain in the limb, with gradual flexion of the elbow-joint.—This is due to puncture of the external or internal cutaneous nerves, which are connected through the brachial plexus with the motor nerves to the brachialis anticus and biceps, which flex the elbow-joint.* The injured nerve should be divided, subcutaneously if possible; or the scar excised.

INJECTION OF SALINE FLUID.

While this method had been occasionally made use of by several different workers for many years—*e.g.*, the Littles in the cholera

* Hilton, *Rest and Pain*, p. 190.

epidemics at the London Hospital in 1848 and 1866, and many others, sporadically, at most of our hospitals,—it was Dr. William Hunter, who, in 1889, by his Arris and Gale Lectures (*vide infra*), again drew the attention of the profession* in this country to the great importance of injection of saline infusion in sustaining life, if only sufficient fluid was added to keep it in circulation. Further, it was Mr. W. Arbuthnot Lane who, applying the above experiments to Surgery in two brilliantly successful cases,† again drew the attention of the profession to the value of this method more forcibly than had been done before.

In his three lectures on Transfusion which Dr. William Hunter gave before the College of Surgeons (*Brit. Med. Journ.*, vol. ii. 1889, pp. 117, 237, 305), the advantages of transfusion and injection of saline fluid are contrasted, and the following most important conclusion arrived at (p. 309):—"For practical purposes all the advantages to be gained by transfusion may, I believe, be equally well and more readily obtained by infusion of a neutral saline, such as $\frac{3}{4}$ per cent. solution of common salt (about 1 drachm to the pint)." It is clearly shown in these lectures that, with regard to transfusion, the nutritive value of *serum* is so small that its chief value here must depend upon its physical properties, and these are in no respect greater than those of a corresponding quantity of neutral saline solution. With regard to the *red corpuscles* the same authority writes (*loc. supra cit.*, p. 305): "The greater the quantity of blood transfused, the longer are red corpuscles likely to remain within the circulation, and the more likely is their hæmoglobin and the iron which it contains to remain within the system. Over this factor, however, we can execute but little control. The quantity of blood transfusable in man can rarely be more than about 5 per cent. of the blood already in the body. And the life duration of the red corpuscles under such circumstances is probably to be reckoned by a period of hours." Again, a little later (p. 308), we are told on this subject that, "it may be stated that there is scarcely a single condition of the blood in which the want of red corpuscles is a source of urgent danger. After the greatest loss of blood in animals, a sufficient number of red corpuscles always remains in the circulation to carry on respiration, provided that the circulation is maintained. . . . In man the loss of blood can never be so great as in animals. Syncope occurs earlier. Transfusion of blood is, therefore, never required for

* About the same time the late Dr. Woolridge, in experiments unpublished owing to his untimely death (and alluded to, *Lancet*, vol. i. 1891, p. 626; *Brit. Med. Journ.*, vol. ii. 1892, p. 491), was also proving that, after hæmorrhage sufficient to be fatal, enough hæmoglobin still remained to sustain life, if only sufficient fluid were added to keep it in circulation. Dr. Herbert R. Spencer (*Lancet*, vol. i. 1892, p. 1289) considers that Golz (*Virch. Arch.*, Bd. xxi. and xxix.), and Kronecker and Sander (*Berl. klin. Woch.*, 1879, No. 52), were the first to suggest saline infusion and explain its action. Dr. Spencer claims (*loc. supra cit.*) the first successful case of injection of saline fluid, in a patient the subject of post-partum hæmorrhage, as long ago as April 1888.

† One of these cases is published (*Lancet*, vol. ii. 1891, p. 626). The other was a case admitted for hæmorrhage after partial removal of the tonsil. Here, by ligature of the common carotid and injection of saline fluid, the patient was rescued from the very gravest peril.

the purpose of supplying red corpuscles to carry on respiration after sudden loss of blood in a patient previously healthy. The immediate source of danger in such cases is not the want of red corpuscles, but the disturbance of the relation between the vascular system and its contents. . . . The immediate source of danger from sudden loss of blood is the fall in the blood-pressure to a point where the circulation is unable to be maintained. The obvious indication, therefore, is to raise the pressure within the vessels." Dr. Hunter then points out that, *bulk for bulk*, pure or defibrinated blood must possess a certain physiological value—*e.g.*, a greater and more immediate effect in restoring the tone of the vasomotor centre than saline solutions. "These advantages, however, are more than neutralised by the greater disadvantages—namely, (1) the difficulty of obtaining blood in sufficient quantity or with sufficient rapidity as compared with the ease with which simple saline solution can be prepared; (2) the danger attending the transfusion if compared with the absolute freedom from danger possessed by salt solution; and (3) the doubtful value of the transfusion, whether hæmogenic or physical, when compared with saline fluid."

The chief **indications** are:

1. Acute traumatic anæmia, such as hæmorrhage after accidents, operations, cut throat, and that connected with childbirth.—Five most carefully reported and instructive cases, under the care of Mr. Pye Smith, of Sheffield, will be found in the *Lancet*, vol. i. 1892, p. 913; of these three were successful. In two Mr. Pye Smith made use of the infusion of saline solution *before* the amputation. Dr. Herbert Spencer's paper, already referred to, and one by Dr. Horrocks, *Obstet. Soc. Trs.*, vol. xxxv., give good instances of the cases in which infusion may be resorted to with benefit in the hæmorrhage of childbirth—*e.g.*, cases of accidental hæmorrhage, placenta prævia, and adherent placenta.

2. Collapse and shock.—Here infusion of saline solution may also be resorted to, but less hopefully, with a view of stimulating the weak action of the heart and combating the loss of vascular tone which accompanies it. The injection of strychnia (gr. $\frac{1}{20}$ of the sulphate) hypodermically is especially indicated here.

As the question of infusion in cases of shock as opposed to collapse is a difficult and very important one, I shall quote from Dr. A. P. Beddard, who, in "Some Remarks on Transfusion and Infusion" (*Guy's Hosp. Rep.*, vol. lv. p. 29), and a Clinical Lecture on Transfusion (*Guy's Hosp. Gaz.*, July 29, 1905), discusses this and several other points in a helpful way, and with the authority of a Physiologist as well as a Physician.

In collapse, whether the fluid has left the body after severe hæmorrhage or only the vascular system, as when it is poured from the vessels into the inflamed or damaged tissues in cases of peritonitis, severe burns, &c., three stages are present. In the first two, the vasomotor centre by great exertion keeps up a moderate blood-pressure, but when it becomes tired out, the blood-pressure rapidly falls and death from collapse takes place. In the second stage, though the pulse may still remain good, the shrunken features of the patient denote an obvious clinical change. "Whenever you see a patient with shrunken features due to loss of fluid you know that he is within measurable dist-

death from collapse at any rate, and whatever other treatment he may require, at least he needs transfusion.

As to shock. Shock and collapse are frequently used as if synonymous terms, but they are not. While they resemble each other clinically to some extent, they differ wholly in their cause and their treatment. Shock, like collapse, is associated with a rapid feeble pulse and abnormal temperature, but the blood-pressure is low from the beginning, and as the patient in shock loses no fluid from his vascular system, his features do not become shrunk. Shock is due essentially to partial inhibition or paresis of the vasomotor centre, which is caused by an excess of afferent impulses reaching the centre. The blood-pressure having fallen considerably, the blood which ought to be in the arteries stagnates in the splanchnic veins especially. Infusion is useless as the fluid infused also stagnates in the splanchnic area. A patient in shock is suffering not from too little fluid in his vascular system but to his blood being improperly distributed. In order to get the blood out of the splanchnic veins into the arteries and to keep a proper proportion there, adequate pressure must be kept up on the abdomen by pad and bandage.

To raise the blood-pressure strychnia and alcohol are of little use because the rise which they bring about is of short duration, as they act, not upon the peripheral arteries but upon the vasomotor centre. This centre, when the stimulation is over, is even more exhausted than before, and the blood-pressure lower. In adrenalin we possess a drug which raises the blood-pressure by acting upon the peripheral arteries. To do so it must be given subcutaneously or intravenously. "It is a good rule never to give a drug intravenously if it can be introduced as well in any other way. Adrenalin given subcutaneously procures temporary glycosuria, but is otherwise harmless. A safe dose for an adult is from 20 to 30 m of a 1 in 1000 solution, or, of course, a corresponding dose of any similar preparation. Its effect upon the blood-pressure comes on within a very few minutes, and has gone in about an hour, therefore the injection has to be repeated about every hour until the shock has passed off. Given intravenously the effect of adrenalin is instantaneous, and it does not last more than ten minutes, therefore it is necessary to infuse continuously a weak solution, such as 1 in 20,000. In passing, it may be pointed out that there is such a thing as preventative treatment of shock by seeing that patients are properly under the anæsthetic before the operation begins, or by giving an injection of morphia soon after a severe bodily injury."

The materials to be used for infusion are next considered by Dr. Beddard. Dextrose is eminently suitable for infusion, being a normal constituent of the blood, and sufficiently non-poisonous to be injected in large quantities. A six per cent. solution of dextrose is theoretically isotonic with human blood plasma. The solution most frequently used is one of sodium chloride, the strength of which should be 3i and not 3j to the pint. Such a solution, unlike one of dextrose, is far from being non-toxic, and while this fact does not prevent its use, the symptoms of possible poisoning by a sodium salt should be remembered. "They are stimulation of the nerves and muscles from slight twitchings up to convulsions, pyrexia up to hyperpyrexia, rigors, feeble and ulse." It is further pointed out that certain cases are much

more liable to poisoning by sodium chloride than others. "All the serious cases of sodium chloride poisoning which I have seen have been cases of uræmia, diabetic, coma, or cholæmia, and it is easy to understand why. In these toxæmias the patient has lost no salts from his vascular system; he has all he ought to have, and you by treatment make a considerable addition to this amount. Therefore he is comparatively easily poisoned. But in cases of collapse, such as peritonitis, diarrhœa and vomiting, &c., the patient, besides water, has lost large quantities of salts as well, and therefore you would have to inject very large quantities of sodium chloride to poison him severely."

Another substance used for a particular case is sodium bicarbonate. "The special case is diabetic coma, and the object is to neutralise the acid intoxication by the alkali as well as to dilute the poison in the blood. The strength to use is 3iv. to a pint. But, and it is a large 'but,' you have to remember that sodium bicarbonate is much more poisonous than the chloride, that in most cases you have no means of measuring the degree of acid intoxication, in other words, the dose of the bicarbonate necessary to neutralise it, and that any bicarbonate in the circulation beyond this dose will exert its poisonous effect.

The last point I shall deal with is *the method of infusing*, and I shall confine my remarks to the question of the choice of route by which fluid is to be introduced. The three possibilities are, a vein, the skin and the bowel. The alimentary canal is often impossible for obvious reasons; there can be little doubt that fluid is absorbed from the subcutaneous tissues with considerable rapidity, provided that the circulation is moderately good. The vein is the most certain and rapid way of getting fluid into circulation, but it undoubtedly has disadvantages and dangers. The choice of route in any given case depends upon two considerations: (1) the nature of the case to be treated, and (2) the kind of solution to be used; for all solutions cannot be given by any or all of the three routes. If you adopt the attitude of not putting anything direct into a vein unless you are driven to do it, then the only thing which will drive you to infuse a patient intravenously is the extreme urgency of the case, that is, the necessity of getting fluid into the circulation with the least possible delay. Cases of such urgency are of considerable rarity; they are cases either of severe hæmorrhage or of other less urgent conditions, in which the circulation has already become so bad that it is doubtful whether fluid would be absorbed from the subcutaneous tissues or alimentary canal. In all other cases infusion by the subcutaneous or alimentary route is certainly preferable, and for these reasons. Intravenous infusion is open to real dangers, which do not exist in the other cases; they are as follows: (a) It is much more serious if the solution is not of the right strength; (b) If there is any danger of the solution causing toxic symptoms in the dose which it is deemed necessary to give, then the intravenous method is much the most dangerous. And for this reason it is always preferable to use a dextrose than any salt solution when intravenous infusion has to be performed. (c) There is a very real danger of over-distending the right heart. I have certainly seen cases where intravenous infusion has caused death in this way. It is difficult to say at what rate fluid can be run into a vein without this danger to the heart. That an apparently small difference in the blood-flow along the veins may make a

great difference to the right heart is clearly shown by venæsection. Here in the course of several minutes we abstract at most a pint of blood from the arm and produce a very real effect upon the condition of the right ventricle. Conversely, it is easy to understand that the injection of fluid into a vein may be serious to the heart. There can be no doubt that the more slowly the fluid is run in the better, and as a maximal rate I would suggest a pint in ten minutes. The rate may appear to err greatly on the side of safety, but I do not think it does. It is necessary to remember that often when intravenous infusion is used the right heart is far from normal, and it is just in uræmic convulsions that I have seen the worst results to the heart. From what has been said as to the limited application of intravenous and alimentary infusion, it follows that the best route in the vast majority of cases is the subcutaneous one, and in some cases it is the only one. For instance, in cases of acute gastro-enteritis in children the bowel is useless for infusion." Of the two ways in which subcutaneous infusion may be employed, the continuous and the intermittent, Dr. Beddard is of opinion that the continuous method possesses no single advantage to outweigh the certain disadvantage, namely, the liability to infection, especially in uræmic and diabetic patients.

It is next pointed out that the choice of route is also determined by the solution to be used. "A solution of dextrose is not suitable for any but intravenous injection. Large quantities given by the bowel may set up diarrhœa, and when injected by the skin they may cause sloughing. But for intravenous infusion for uræmia and for loss of fluid from the vascular system, it is the best solution to use. A solution of sodium chloride may be given in any of the three ways. The objections to its use intravenously have already been discussed. It is the best solution to use for subcutaneous or rectal infusion. A solution of sodium bicarbonate should not be given subcutaneously because of its liability to produce sloughing. In most cases of diabetic coma there is plenty of time to give alkali by the mouth or rectum. Strong solutions may be used; thus, 3vi. in 3vi. of milk or water may be introduced several times a day into the stomach or rectum. If you wish to give it intravenously, give a pint of fluid containing 3iv. of sodium bicarbonate, and test the reaction of the urine and repeat at intervals of a few hours until the urine becomes nearly neutral."

With reference to the treatment of combined shock and collapse, Dr. Beddard's advice is as follows: "In most cases subcutaneous injections of a sodium chloride and of adrenalin solution meet the condition. When, however, the collapse needs intravenous injection, the adrenalin may be put into this fluid in the strength of 1 in 20,000; but, even in this case, I think it is far safer to give the adrenalin subcutaneously."

As many lives are lost from want of infusion, and not a few because infusion is not sufficiently repeated, the best course for those in doubt will be to make intravenous infusions at intervals of a few hours, perhaps into the median basilics; then to infuse into the cellular tissue of the axillæ; and then, if needful, to resort to infusion into the internal saphenous veins. Small cannulæ should be at hand for use in children.

Several years ago the late Dr. Sturges published (*Lancet*, vol. i. 1892, p. 86) a case in which severe collapse from vomiting and diarrhœa in a child of nine months, the subject

of congenital syphilis and rickets, was successfully tided over by the infusion of salt solution injected by Mr. Horace Collier. Other treatment having failed, the left external jugular was exposed, and 12 ounces of distilled water containing 36 grains of common salt and rather more than a drachm of brandy were slowly injected. The very marked restlessness which followed was combated with opium. The child recovered.

3. Other, rarer, indications are diabetic coma and septicæmia; in the latter on the ground that it facilitates the removal, especially by the kidneys, of the micro-organisms and their toxins. The question of infusion in diabetic coma has been considered above (p. 138), the infusion of a solution of formalin in septicæmia is referred to at p. 144. For a scientific opinion on what benefit infusion may, perhaps, bring about in certain cases of uræmia, acute nephritis and puerperal eclampsia, I must refer my readers to Dr. Beddard's paper, *Guy's Hosp. Rep.*, *loc. supr. cit.*

4. In the case of certain poisons—*e.g.*, carbolic acid—Dr. Oliver, of Newcastle (Prof. Allbutt's *System of Medicine*, vol. ii.), drew attention to the insufficiency of washing out the stomach when once a poison like carbolic acid has got into the blood, and to the need of infusing with saline fluid, as this is in great part rapidly excreted by the kidneys and carries much of the poison away with it. It is to Dr. Powell, House-Physician at the Royal Infirmary, Newcastle, that the merit is due of putting the above opinion to a most successful test (*Lancet*, 1898, Nov. 19, p. 1326).

A woman, æt. 21, who had, about three-quarters of an hour before her admission, swallowed seven drachms of ordinary commercial carbolic acid, was brought in, in a state of coma and collapse. While the stomach was being washed out, the left internal saphena was opened in the leg, and eight ounces of blood removed.* Four pints of a saline solution, at a temperature of 110°, were then injected. Half a pint of milk beaten up with two eggs was given by the stomach-tube. The pulse and respiration gradually improved. Glycerine in drachm doses was given frequently to allay the burning sensation in the pharynx and œsophagus. For three days the urine was dark green, but never contained albumen. Recovery was rapid and complete.

5. Another condition, from its urgent gravity, deserves mention here, and that is gas-poisoning.

This appears to be more common in America, both in private and hospital practice, than with us. Dr. Taylor (*Medical Record*, July 9, 1904) gives his conclusions from 90 cases, in 12 of which necropsies were obtained. He considers that venesection and saline infusion, usually combined, should be promptly employed. Where, in an unconscious patient, the pulse does not justify venesection, infusion alone should be made use of. Where the pulse is vigorous, venesection followed by saline infusion is the remedy. It is advised to withdraw 15 or 18 ounces of blood rather than 8 or 10 whenever the pulse will admit of this, and at least 1500 cc. of saline infusion should be infused. This may be repeated on the opposite side, or given under the skin, or per rectum. There is no reason, in Dr. Taylor's opinion, to believe that saline infusion will produce pulmonary œdema, while there are many cases in which a large dose of the poison renders the patient's condition hopeless; in a considerable proportion the improvement following venesection and infusion ends in recovery. How the two remedies act is uncertain.

Method (Fig. 68).—Now that the indications for saline infusions have been proved to be numerous, and so often followed by excellent results,

* Commenting on this step, the Editor of the *Lancet* expressed his doubts as to whether much benefit can be expected from it, owing to the limited quantity of blood and, therefore, the small corresponding percentage of the poison, which can be withdrawn.

every practitioner should be prepared to employ this method, remembering the critical nature of the cases which call for it, and the suddenness with which the call is liable to come. The instruments used should be as simple as possible. A teaspoonful and a half of common salt is dissolved in water which has been recently boiled.* Four to six pints of such a solution should be at hand, and kept, covered, at a temperature of about 100°. Also cannulæ,† india-rubber tubing

FIG. 68.



Dr. Horrocks' method of saline infusion. *Trans. Obstet. Soc.*, vol. xxxv.
(Down, Bros.).

half an inch in diameter and four feet in length, and a glass funnel. The skin over the vein selected is first sterilised. The vessel chosen is usually the median basilic or the cephalic. Either is exposed by an

* The use of milk, which has been employed by some—*e.g.*, Dr. Thomas, of New York—as safer and more nutritious than saline infusion, should be rejected absolutely. Both claims are quite unfounded for infusion purposes. Dr. Schäfer (*loc. supra cit.*) found that the injection of milk, after dogs had been reduced by bleeding to an almost lifeless condition, caused a temporary rise in the blood-pressure but no permanent benefit. After death the blood corpuscles were found to be disintegrated, and the blood swarming with bacteria.

† Blunt-pointed cannulæ are, in my opinion, preferable to those with sharp points. The latter are said to have the advantage of more readily entering a collapsed vein, but, in my experience, it is easy to send a sharp-pointed cannula between the coats of the vein, or to transfix it. Cannulæ of various sizes should be at hand. I have not described infusion by means of a syringe. This entails more difficulty in sterilising, the piston does not always fit snugly, and a syringe allows of more opportunities of admitting air into the circulation.

oblique incision beginning to the inner or outer side of the biceps tendon. Where there is any difficulty in finding a vein here, owing to their collapsed state or to the arrangement not being normal, a skin-flap should be turned up, or gentle pressure made on the basilic or the cephalic a little higher up, and the trunk exposed here. Or the patient's leg may be allowed to hang down, and the internal saphena opened just in front of the malleolus. Two sterilised silk threads are now passed under the vein exposed. One is drawn to the lower angle of the wound, tied round the vein and cut short. The vein being raised with dissecting forceps, a small nick is made in it with scissors, care being taken not to sever it completely. The cannula is next introduced into the vein and tied in by the upper ligature, the ends of which are left long as in Fig. 68. The blood now flows down the cannula, and when it is full, the tubing, previously attached to the funnel and filled with saline solution, is fixed on to the cannula. The funnel is now raised about four feet, and as the solution flows it is replaced by more poured from a jug held close to the funnel to avoid the formation of bubbles. When enough has been infused the cannula is removed. The vein is cut completely across, and the upper end tied with the ends of the ligature which have been left long.

It should take at least from twenty to thirty minutes to inject two to three pints of saline fluid, the amount usually required; five or six pints being sometimes needed: the more slowly the fluid is infused, the better. Care must be taken, while the fluid is being injected, that no air enters, and that there is no kinking or blocking of, or leakage from, the apparatus employed. The chief guides are the return of the pulse, with increase in volume and diminution in rate (say a fall from 130 to 90), return of colour and fulness to the face, increase in consciousness, &c. The operation having been completed, the remaining ligature is tied just below the opening in the vein, and the little wound closed and dressed with aseptic precautions. Any thick scar in front of the elbow-joint will embarrass its movements.

Where the necessary apparatus cannot be procured, or in cases of severe hæmorrhage where all the bleeding points cannot be controlled, and where the injection of saline fluid will thus defeat the only means of arresting the bleeding, *e.g.*, clotting, one or two pints may be very slowly injected into the cellular tissue of the axillæ.

TRANSFUSION.

As it is still disputed how far transfusion of blood is useful in such diseases as pernicious anæmia, this operation will be described here, though it is clear that in the very great majority of indications it has been replaced by infusion of saline solution, chiefly on account of the difficulty with which sufficient quantity of blood is obtainable.

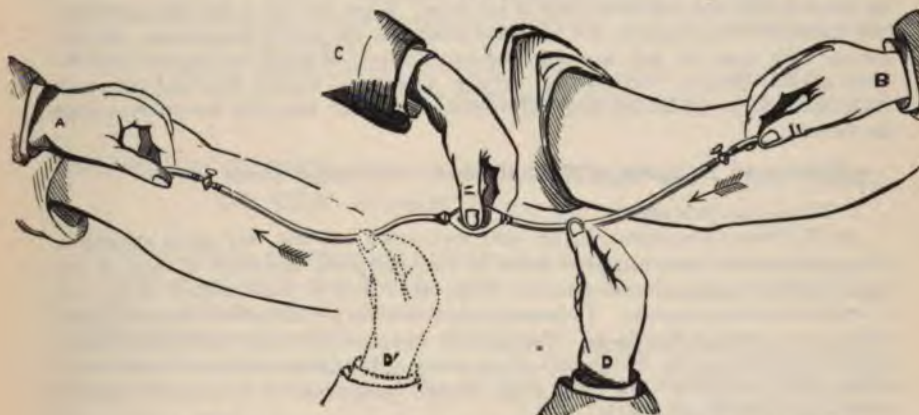
With regard to transfusion in pernicious anæmia, Dr. Hunter (*loc. supra cit.*) spoke as follows: "In idiopathic anæmia, pernicious anæmia, and leucocythæmia, transfusion of blood can, in my opinion, never be indicated. In both the condition of the blood is the result of changes in the blood-forming or blood-destroying processes, or both. In leucocythæmia the disturbance is one of blood-formation in the first instance, evidenced by the increase of the leucocytes of the blood, while the diminution in the number of the red I find to be due in great part to excessive blood-destruction, probably induced by the activity of the leucocytes. In pernicious anæmia, the condition of the blood is mainly the result of excessive destruction. Transfusion of blood under such circumstances is not

unattended by dangers, as we have seen, but is followed in most cases by rapid destruction of the red corpuscles, as evidenced by fever, sometimes by hæmoglobinuria, occasionally also by increase in the slight icterus which so frequently marks the progress of the disease." On the other hand, at a meeting of the Edinburgh Medico-Chirurgical Society (*Lancet*, vol. i. 1892, p. 24), Dr. Brakenbridge and Dr. Affleck claimed successful cases.

Dr. J. R. Philpots (*Brit. Med. Journ.*, vol. i. 1894, p. 162) also mentions a successful case in which the transfusion was performed by Mr. C. E. Jennings. Here 16 ounces of blood were transfused, the blood mingling "in its passage with about 10 ounces of saline fluid, and about 16 ounces of saline fluid were infused into the donor's veins to replace the blood given."

One other condition in which transfusion of blood, aided perhaps by infusion of saline

FIG. 69.



A and B are the hands of assistants holding the afferent and efferent tubes and the lips of each venæsection wound together. The cannulae being inserted into the veins, the bulb and tubing, filled with warm saline solution, and kept so by the taps or clips, are fitted into the cannulae. Then the taps are turned or the clips removed, and the tubing compressed by D, and the bulb squeezed by C. The tube is then squeezed by shifting D to D'. The bulb then expanding draws in blood, when the manipulation just described is repeated. The bevelled end of the afferent tube is so made that it may slip easily into the collapsed vein of the patient. (Aveling, *Obst. Trans.*, vol. vi., May 4, 1874.)

solution, may be beneficial, is poisoning by carbonic oxide gas. Here, perhaps, it would be well to get rid of some of the poisoned blood by a preliminary blood-letting.

There are two methods—A. Direct, in which blood is conveyed directly from one person into another; and B. Indirect, in which blood separated from its fibrin, or some other fluid, is thrown in.

Direct.—Owing to want of space I shall describe this alone. It is probably preferable to inject blood without exposure to air and without manipulation in the few cases in which this method may be called for.

Method.—(Fig. 69.) DR. AVELING'S, MODIFIED BY MR. CRIPPS.—As I have only space for one here, I shall describe that with which I am most familiar. It is simple and inexpensive,* and has the advantage of measuring the blood sent—viz., two drachms at each squeeze of the bulb.

* I may remind my readers that, as in the case of all india-rubber instruments, this, unless kept carefully and looked at from time to time, is liable to be found cracked and useless at the moment of need. Mr. Cripps (*Dict. of Surg.*, vol. ii. p. 660) has removed one source of clotting by replacing with clips the taps shown in Fig. 69.

The skin having been cleansed, the veins exposed and probes passed beneath them, the apparatus is filled with a warm sterilised solution of sodium chloride, and a clip placed at either end. The arms of receiver and donor being in the position given above, the vein of the receiver is opened with sharp scissors, and, pressure being made just below the opening in the vein, so as to prevent blood obscuring the opening, the cannula is inserted. The other cannula is then inserted into a vein of the giver, and both are held steadily by an assistant. Transfusion is then performed as follows:

"The clips having been removed from the tube at either end, the operator makes the necessary valve to prevent regurgitation by compressing, with the finger and thumb of one hand, the tube between the central ball and the giver. He then slowly squeezes the ball, with the effect of driving the water it contains gently into the vein of the recipient; then, having compressed the tube between the ball and the recipient, he removes the finger and thumb from off the tube on the opposite side, allowing the ball to expand with the blood coming into it from the arm of the giver. When the ball is full the manipulation just described is repeated, and the blood passes into the vein of the receiver. In this manner, each time the ball is compressed, two drachms of blood are injected into the veins of the patient. Should the syringe appear to become blocked,* or work unsatisfactorily, it can be detached and washed out without removing the cannulae from the veins."

Risks and Dangers of Transfusion.—Amongst these are:

1. Emboli and their results.

Dr. W. Hunter (*loc. supra cit.*, pp. 306, 307) points out that very grave symptoms, due to widespread thrombosis and spasm of the capillaries, especially of those of the gastro-intestinal mucous membrane and lungs, may follow on transfusion of blood, with or without sodium phosphate. The most frequent of these are abdominal pain, diarrhoea, albuminuria, hæmoglobinuria, &c. Furthermore, one great feature of defibrinated blood, however obtained, is the uncertainty of its action. It is sometimes quite harmless, at others highly dangerous—this result being entirely independent of the quantity injected, or the care taken in injecting it.

It has been suggested that some saline solution having the power of delaying the coagulation of blood—*e.g.*, sodium phosphate—should be added to the blood before it is transfused (Braxton Hicks, *Guy's Hosp. Rep.*, vol. xiv.). Dr. W. Hunter (*loc. supra cit.*, p. 305) condemns the use of this salt. He is of opinion that the use of even a $\frac{1}{4}$ per cent. solution of sodium phosphate will cause the red corpuscles to break up within twenty-four hours, and that the use of this salt along with blood will not prevent the occurrence of those capillary thromboses which are known to follow on transfusion of blood by itself.

Except for those cases where infusion of saline solution has failed, or where, as in pernicious anæmia, it is desired to inject blood and to add to the amount injected, it is not likely that the employment of sodium phosphate will be continued.

2. Evidence of blood being thrown in too rapidly for the system of the receiver—*e.g.*, headache, flushing, præcordial oppression, &c.

3. Perhaps septic absorption, if the blood has been exposed too long.

4. Many of the risks already given under the head of "Venæsection" (p. 134) will, of course, be present here also.

INTRAVENOUS INJECTIONS OF ANTISEPTICS.

This was, I believe, first put to practical use by C. C. Barrows (*New York Med. Journ.*, January 31, 1903). His case was one of severe sepsis after a confinement, in a negress, æt. 26. Examinations of the blood had shown an absence of malarial organisms, a leucocytosis of 18,000, and a blood-culture had given a pure culture of streptococcus. When seen by Barrows, the patient was in low muttering delirium with a temperature of

* A case in which this occurred will be found related by Dr. Hoggan, *Brit. Med. Journ.*, 1877, vol. ii. p. 726.

108 degrees, P. 150—160, and R. 38. There were no local signs or symptoms. 500 cc. of a 1 in 5000 aqueous solution of formalin were infused. In three hours the temperature had fallen to 105 degrees, in six hours to 101 degrees, the P. being 104, and R. 28. In twelve hours, after fluctuations, the temperature rose to 103 degrees, although the P. did not go higher than 112. A second infusion of 750 cc. of the same solution was then given. There was a slight chill without a further rise of temperature, which in the next twelve hours fell to normal, where it practically remained. At the time of the report the woman was to all appearances entirely well. A number of cultures made since the first infusion failed to show any streptococci. No changes were noted in the red corpuscles. Albumen, present in the urine before the infusion, disappeared, and there was no hæmaturia.

The author warns the profession against the indiscriminate use of this remedy when proper blood cultures have not been made, and against considering it a substitute for the proper surgical measures, indicated in each individual case. It is to be noted that in this case the uterus had been curetted.

W. L. Bauer very shortly followed (*New York Med. Journ.*, Mar. 21, 1903) with a case very similar to that of Barrows, in which formalin was thus employed without any good result.

LIGATURE OF THE BRACHIAL ARTERY AT THE BEND OF THE ELBOW (Figs. 53, 70 and 71).

This operation, common enough fifty years ago owing to the frequency of venæsection and the facility with which the brachial artery was wounded, will be briefly described here.

Indications.—(1) Wound of the artery, especially after venæsection, or tenotomy of the biceps tendon (here a ligature above and below the wound will be required), or a flying chip of metal (Williamson, *Brit. Med. Journ.*, vol. ii. 1896, p. 1511). (2) Traumatic aneurysm, whether arterio-venous or no, also occurring after accidents such as the above.

The late campaign in South Africa saw a great increase in the occurrence of arterio-venous aneurysms from the passage of high velocity bullets of small calibre through adjacent arteries and veins. This subject will be referred to at p. 167 in the account of ligature of the axillary artery, the vessel of the upper extremity in which, according to Mr. G. H. Makins, C.B., operative interference is most likely to be useful.

GUIDE.—The inner side of the biceps tendon.

RELATIONS :—

IN FRONT.

Skin; fasciæ; bicipital fascia; median basilic vein. Branches of internal and external cutaneous nerve.

OUTSIDE.

Biceps tendon.
Vena comes.

Brachial artery
at bend of elbow.

INSIDE.

Median nerve.
Vena comes.

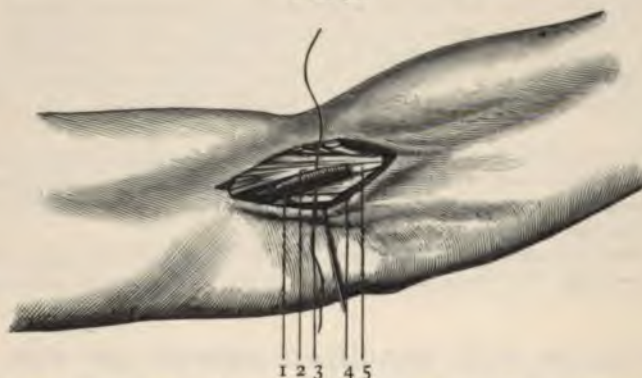
BEHIND.

Brachialis anticus.

Operation (Figs. 53, 70 and 71).—The limb being steadied, with the elbow slightly flexed, the site of the biceps tendon should be defined, and also that of any large veins, by making pressure a little above the proposed site of ligature. An incision about $2\frac{1}{2}$ inches long is then made, a little to the inner side of the biceps tendon, through the

superficial fascia carefully, so as to avoid the median basilic vein and its companion, the internal cutaneous nerve. If these are seen, they must be drawn inwards. The deep fascia is then divided on a director,

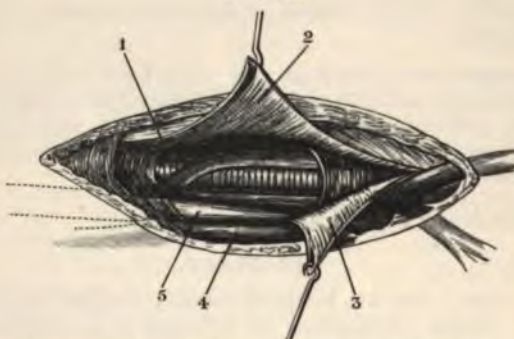
FIG. 70.



Ligature of the brachial artery at the bend of the elbow. 1, Artery surrounded by its venæ comites, from the inner of which a branch passes to 4 (basilic vein). 2, Bicipital fascia. 3, Median nerve. 4, Basilic vein. 5, Biceps tendon. (Too much of the artery is shown cleaned.)

this and the semilunar fascia of the biceps, which strengthens it, being interfered with as little as possible. The artery, with its venæ comites,

FIG. 71.



Incision for ligature of brachial artery at the bend of the elbow (left), shown dissected. 1, 2, 3, Tendon of biceps and outer and inner flaps of bicipital fascia. 4, Basilic vein. 5, Median nerve. The artery is seen surrounded by its two venæ comites, the sheath having been freely removed. (Farabeuf.)

lies directly underneath. The needle should be passed, after the veins are separated and the artery cleaned, from within outwards, so as to avoid the median nerve, which lies more deeply on the inside.*

* If it be needful to prolong the incision downwards so as to secure the upper end of the radial or ulnar, the bicipital fascia must be divided more freely, and the median basilic vein secured if it cannot be drawn to one side.

In the case of traumatic aneurysm, arterio-venous or no, resisting other treatment, a proximal ligature placed as near as possible above the sac, or the old operation of placing double ligatures,* will be preferable to the Hunterian one, which runs the risk of overlooking the possibility of a rather higher division than usual of the brachial into radial and ulnar. If much hæmorrhage is expected, the brachial should be compressed about the middle of the arm with an Esmarch's bandage. The median basilic vein will, in many cases of arterio-venous aneurysm, be found much dilated by the entrance of arterial blood. Occasionally it has been obliterated. In ordinary traumatic aneurysm, the sac should be cut away with scissors, after the artery above and below has been secured.

This operation at the bend of the elbow should always be performed with the utmost carefulness at the time, and pains taken with the after-treatment, so as to ensure the minimum of disturbance and the smallest amount of cicatrix, and thus to interfere as little as possible with the movements of the elbow.

* On this and all other arterio-venous aneurysms the advice of Mr. Makins, p. 167, should be studied. It will be seen that he prefers trial of a proximal ligature first. If a local operation is found to be needful, ligatures will be required above and below the communication with the vein in the case of aneurysmal varix, and above and below the sac if the surgeon is dealing with a varicose aneurysm. It may be better (the artery being commanded above) to open the sac, and thus find the apertures into the artery by the aid of a small bougie. As Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 92) points out, the other plan of attempting to find and tie the artery without opening the sac presents these difficulties—viz., that the artery is surrounded by dilated and closely packed veins, and that below the sac it is of small size. Every precaution should be taken to spare the main vein. If hæmorrhage from it, uncontrollable by pressure, be present, a lateral ligature should be attempted. Only, if it be absolutely unavoidable, should the vein be tied above and below.

CHAPTER V.

OPERATIONS ON THE ARM.

LIGATURE OF BRACHIAL ARTERY (Figs. 53, 70, 71 and 72).

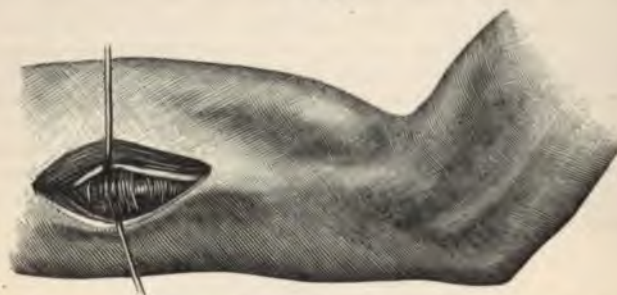
THIS is performed (a) in the middle of the arm, and, much more rarely, (b) at the bend of the elbow, the operation last described.

(a) **In the Middle of the Arm** (Fig. 72).

Indications.

1. Chiefly wounds of the palmar arch, resisting pressure (p. 36).
2. Wound of the artery itself by a penknife,* bayonet, bullet, &c.

FIG. 72.



The upper hook draws aside the biceps and the median nerve; the lower, the basilic vein and the triceps. The inner vena comes is seen in the bottom of the wound. The sheath of the artery has been opened and a small portion cleaned ready for the passage of the ligature.

3. Gunshot wound of the elbow, leading to secondary hæmorrhage resisting other treatment.
4. Angeioma of hand.

In March, 1891, I tied first the brachial, and, five months later, the radial and ulnar arteries, for a congenital angeioma with much erectile tissue affecting all the fingers and the palm of the hand in a girl aged 18. By the first operation the vascularity was quickly

* Mr. Shield (*Lancet*, 1887, vol. i. p. 978) has recorded a case of stab-wound of the brachial, with several points of interest. A penknife wound had reached the artery by passing from without inwards through the biceps. The bleeding was arrested by pressure. The wound healed, and twenty days later a fall caused the cicatrix to give way, profuse hæmorrhage following. Esmarch's bandage being applied, a free incision was made, and the bleeding point found by searching with a bent probe, the end of which passed into an opening in the brachial artery. Ligatures were applied above and below. Owing to the swelling of the arm no sutures were used. A good recovery took place.

reduced; the second, aided by catgut setons, was followed by very marked shrinking, and, ultimately, a complete cure. A full account of the case with the result, ten years after the operation, is given in the *Guy's Hospital Reports*, vol. lvi.

5. Wound of one of the arteries of the forearm, followed by severe hæmorrhage, a sloughy condition of the parts preventing ligature of the vessel above and below the wound.

In the year 1882 a patient came under my care for secondary hæmorrhage from a wound of the forearm, inflicted by the bursting of a gun in rook-shooting. The parts were much swollen and sloughy: the ulnar artery in its middle third, from which the hæmorrhage was coming, was greenish in colour, and apparently not in a condition to hold a ligature. A good recovery, with no further hæmorrhage, took place after ligature of the brachial in the middle of the arm.

In 1885 I had occasion again to tie this artery, for hæmorrhage occurring repeatedly a few days after a suppurating palmar bursa had been opened in the usual way, above and below the anterior annular ligament. The patient recovered with a weakened limb.

6. Traumatic and spontaneous aneurysm. In traumatic aneurysm, whether of the brachial or the arteries of the forearm, the old operation is preferable to the Hunterian, as the sac is often imperfect.

Dr. H. Bousquet records (*Congrès Franç. de Chir.*, 1895, p. 741) a case of traumatic aneurysm* of the forearm, dating to a gunshot injury, cured by excision of the sac.

A labourer, while poaching, received a charge of No. 6 shot, which, entering in the lower third of the forearm, passed obliquely upwards almost as high as the elbow. The wound healed in about six weeks. Evidence of an aneurysm became manifest thirteen days after the injury, but operative treatment was refused. Six months after the accident, an Esmarch's bandage having been applied, an incision was made over the swelling, which was now of a pyriform shape, and reached from the middle of the arm to the lower third of the forearm. The brachial artery having been tied as low down as possible, the aneurysm was separated from the adjacent structures. In spite of much care, its walls, which were very thin, gave way at several spots. Its interior was filled with passive clot. Its lower extremity was embedded in the cicatrix of the wound. The aneurysm probably sprang from the arteries of the forearm near their origin, perhaps also from the brachial. The removal of the aneurysm left a large cavity, of which the floor was formed by the interosseous membrane, and the sides by muscles of the forearm. Several vessels were tied before and after the removal of the Esmarch's bandage. As it was impossible to bring so large a wound together, it was plugged with iodoform gauze. The patient recovered with a useful limb.

With regard to spontaneous aneurysms, it is well known that these are very rare in the upper extremity, and usually associated with cardiac disease. When this complication is present, ligature will only be thought of when the aneurysm is rapidly increasing, or causing painful pressure upon a nerve. Eucaïne may be useful here.

LINE.—From the junction of the middle and anterior thirds of the axilla, along the inner edge of the coraco-brachialis and biceps, to the middle of the elbow-triangle. This line is of especial importance, when, owing to swelling, &c., the edge of the biceps is difficult to make out.

GUIDE.—The above line and the inner edge of biceps.

* The aneurysm is also described as arterio-venous, but no evidence of this is given. The account of the vessels affected is practically *nil*.

RELATIONS in arm :— IN FRONT.

Skin ; fasciæ ; branches of internal and external cutaneous nerves.

Median nerve* (about the centre of the arm).

OUTSIDE.

Coraco-brachialis (above).

Biceps.

Vena comes.

Brachial
artery
in arm.

INSIDE.

Ulnar nerve.

Internal cutaneous nerve.

Vena comes.

Basilic vein, superficial to deep fascia in lower half, beneath it above, usually.

BEHIND.

Triceps (middle and inner heads) ; coraco-brachialis ; brachialis anticus.

Musculo-spiral nerve and superior profunda artery (above).

Collateral Circulation.

(a) If the ligature be placed above the superior profunda, the vessels chiefly concerned will be—

Above.

The subscapular }
The circumflex }

with

Below.

The superior profunda.

(b) If the ligature be placed below the superior profunda—

Above.

The superior profunda with

Below.

{ The radial recurrent.
The posterior ulnar recurrent.
The interosseous recurrent.
The anastomotica magna.

(c) If the ligature be placed below the inferior profunda—

Above.

The superior profunda }
The inferior profunda }

with

Below.

{ The radial recurrent.
The ulnar recurrents.
The interosseous recurrent.
The anastomotica magna.

Abnormalities.—These are so far from infrequent† that the surgeon must be prepared for the following :

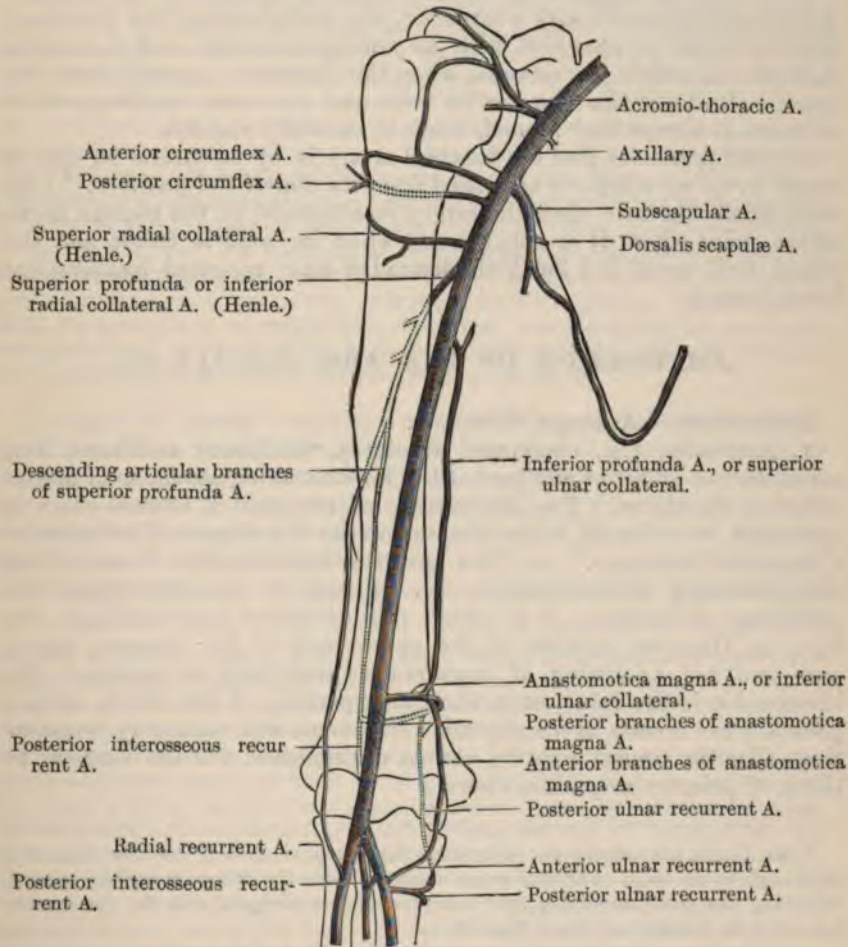
1. The artery being in front of the nerve.
2. A high division of the artery. According to Mr. Quain, in one out of every five cases there were two arteries instead of one in some part, or in the whole, of the arm. The point of bifurcation is thus described by Gray : "It is most frequent in the upper part, less so in the lower part, and least so in the middle, the most usual point for the

* In one out of every six cases the median nerve lies under the artery (Skey, *loc. supra cit.*, p. 269).

† Numerous instances of these are figured by Mr. Reeves in the Appendix to his *Human Morphology*, vol. i. p. 692 *et seq.*

application of a ligature; under any of these circumstances, two large arteries would be found in the arm instead of one. The most frequent (in three out of four) of these peculiarities is the high origin of the radial. That artery often arises from the inner side of the brachial, and runs parallel with the main trunk to the elbow, where it crosses it,

FIG. 73.



Anastomosing branches of axillary and brachial arteries. (MacCormac.)

lying beneath the fascia; or it may perforate the fascia, and pass over the artery immediately beneath the integument."*

3. The artery may be partially covered by a muscular slip given off from the pectoralis major, biceps, coraco-brachialis, or brachialis anticus.

4. One or more slender vasa aberrantia may be met with in the arm, passing from the axillary or the brachial to one of the arteries in the forearm.

* The possibility of this superficial position of the radial or ulnar should always be remembered when venesection, or ligature of the brachial, at the elbow is about to be performed. See also the footnote, p. 133.

Operation (Fig. 72).—The arm being extended and abducted from the side, with the elbow-joint flexed and supported* by an assistant, the surgeon, sitting between the limb and the trunk,† makes an incision 3 inches in length along the inner border of the biceps, beginning from below or above as is most convenient, going through the skin and fasciæ, and exposing just the innermost fibres of the muscle.‡ This is then drawn outwards with a retractor, the median nerve next found and drawn inwards or outwards with an aneurysm-needle, and the artery defined and sufficiently cleaned, when the ligature is passed from the nerve. In doing this the basilic vein and the venæ comites, which increase in size as they ascend, must be carefully avoided.

I would point out that the brachial artery is by no means so easy a vessel to tie as might be supposed from its superficial position. This is especially the case when the artery is concealed by the median nerve at the point where it is sought, and when its beat is feeble and the vessel itself small and but little distended after repeated hæmorrhage lower down.§

AMPUTATION OF THE ARM (Figs. 74 to 77).

Indications.—Amongst these are :

1. Accidents, *e.g.*, compound fractures, machinery accidents, &c., which do not admit of any part of the forearm being saved, or of amputation at the elbow. The advisability of amputation in such cases is discussed, once for all, in the chapter on the "Antiseptic Treatment of Compound Fractures." 2. New growths involving the forearm, and not admitting of extirpation. 3. Disease of the elbow-joint not admitting of excision, or in which this operation has failed (pp. 76, 85). 4. Gunshot injuries of the upper part of the forearm, elbow, and arm not admitting of conservative treatment or excision. So inestimable is the value, even when only partial, of the hand, and so good are the results of conservative treatment and secondary amputation, that the tissues must be almost disorganised for the surgeon to think of primary amputation here.||

* Mr. Heath has pointed out (*Operative Surgery*, p. 18) that if the arm, when at a right angle to the body, be allowed to rest upon the table, the triceps is pushed up, and, displacing the parts, may bring into view the inferior profunda and the ulnar nerve instead of the brachial and the median nerve.

† This is, to my mind, a much more comfortable position than standing on the outer side and looking over.

‡ Authorities differ as to this step. I strongly advise the operator to avail himself of this guide. If it be done carefully, and the wound kept aseptic afterwards, it can do no harm. The fibres of the muscle are a distinct help, and (as stated above) ligature of this artery is not so easy a one as it would appear.

§ This was so marked in the last of my three cases mentioned at p. 149, that, when I exposed the vessel, several bystanders felt certain that it was not the brachial, but one of its branches.

|| Dr. Otis, writing in 1883 (*loc. supra cit.*, p. 916), thus summed up on the question of conservative surgery, excision, and amputation in gunshot injuries of the elbow-joint :—"The practical conclusions that appear to be deducible from the foregoing investigations are—(1) That in shot wounds in young healthy subjects attended with slight injury of the articular extremities of the bones of the elbow, such as fractures of the

The following (Reclus, *Cong. Franç. de Chir.*, 1895, p. 682) is a good instance of what conservative surgery may effect, should the patient refuse to submit to amputation, or decide to face the risk of blood-poisoning, tetanus, &c., when these dangers have been fully put before him.

In a man, æt. 53, whose left upper limb had been caught between a lamp-post and a furniture-van, the middle of the forearm was shattered as follows:—The skin was stripped off over the whole circumference, save at one spot on the ulnar border. All the muscles, anterior, posterior, and external, were destroyed down to the bone, and formed above and below retracted masses bounding a deep gap, at the bottom of which lay the radius and ulna, each broken into three fragments, some of which were overriding the others. The large vessels and nerves had alone escaped; the sensibility of the hand was not interfered with. The wound having been thoroughly cleaned—dirt, clots, débris of fasciæ, tendons, and muscles, and some splinters of bone quite bare of periosteum having been removed—the soft parts were in a measure drawn together by means of stout silk, the sutures taking up muscles and skin. The fragments of the bones were got into place with difficulty. The wound was dressed once every three weeks. Consolidation of the bones was not obtained until the end of four months. But the result was surprising. The forearm was useful, the continuity of the muscles being established. The thumb was free and active, and opposed itself very easily to the fingers, which were becoming less stiff every day. Here amputation above the elbow-joint was the only alternative.

Amongst the special conditions which will have to be considered are the size and character of the projectile, the gravity of the laceration of the soft parts, the amount of longitudinal splintering of the bones, the extent of lesions to the vessels and nerves, and the degree to which conservative measures can be adopted in the absence of hospital facilities or of easy transportation.*

If the surroundings of the surgeon and patient admit of it, attempts

olecranon, of the outer condyle, or of the trochlea, without much splintering and without lesion of the important vessels and nerves, it is justifiable in many instances to attempt an expectant conservative treatment, keeping the injured extremity in entire rest, after removing any detached fragments or foreign bodies, in a semi-prone and very flexed position, employing ice or other cold applications. If the inflammatory action becomes intense, the wounds should be freely enlarged and the joint-cavity freely laid open, and easy escape provided for the altered wound secretions by position and drainage-tubes. The strength should be sustained by a tonic regimen, and when the inflammatory stage has completely abated, and not before, if healing is slow, secondary excision or amputation may be hopefully resorted to. Unless all the favourable conditions mentioned are present at the outset, it would be safer to resort to primary excision or to amputation. (2) In grape-shot communications with lesions of the principal vessels or nerves, amputation should be practised immediately after the reception of the injury. (3) In severe shot-fracture, without extensive lesion of the soft parts, the joint should be freely exposed by a longitudinal posterior incision, and the full extent of the fracture ascertained. Unless there is extraordinary fissuring, the injured joint-ends should then be sawn off as close to the limits of injury as possible, save that the bones of the forearm should be shortened to the same level. If the splintering extends very far, or if there is reason to believe that the humeral vessels are injured though not wounded, the incision should be so modified as to convert the operation into an amputation."

* On this point Dr. Otis writes (*loc. supra cit.*, p. 811): "The surgeons, doubtless, sometimes yielded to what John Bell called 'an argument of necessity as well as of choice, and limbs, that in happier circumstances might have been preserved, had often, in a flying army or a dangerous campaign, to be cut off,' since 'it is less dreadful to be dragged along with a neat amputated stump than with a swollen and fractured limb, where the arteries are in constant danger from the splintered bones.'"

will, nowadays, be made to suture the nerve ends, especially when only one or two of the chief trunks are involved.

I have already referred at p. 120 to the infrequency of severe gunshot injuries to the elbow-joint in the late war.

It is noteworthy here that Mr. G. H. Makins, C.B., writes (*Surgical Experiences in S. Africa*, 1899—1900, p. 11): "I am unable to say what was the proportional number of shell wounds among the men hit, but I can say with some confidence that it was not as great as 10 per cent. I should be inclined to place it as low as 5 per cent. Again, I cannot fix the proportionate occurrence of wounds from bullets of large calibre, such as the Martini-Henry, but this was certainly not large. I think if 10 per cent. is deducted to represent the number of hits from either of these forms of projectiles, that we may fairly assume the remaining 90 per cent. of the wounds to have been produced by bullets of small calibre." In addition to the small size of the bullets, the distance which, generally, separated the two enemies, is a factor which must be taken into account. With regard to treatment of wounded joints Mr. Makins states (p. 235) that this was generally simple. "The old difficulties of deciding on partial as against complete excision or amputation was never met with by us. We had merely to do our first dressing with care, fix the joint for a short period, and be careful to commence passive movement as soon as the joints were properly healed, to obtain in the great majority of cases perfect results. If suppuration occurred, the choice between incision and amputation had to be considered. In the early stages this choice depended entirely on the nature of the injury to the bones. If this were slight, incision was the best course to adopt. I saw several cases so treated which did well, although convalescence was often prolonged, and only a small amount of movement was regained. Amputation was sometimes indicated in cases of severe bone-splintering when the shafts were implicated, but was as a rule only performed after an ineffectual trial to cut short general infection of the septicæmic type by incision. I should add that, on the whole, suppuration of the joints was uncommon, except in the case of injuries far exceeding the average in primary severity." With regard to the elbow-joint in particular Mr. Makins writes (p. 236): "Injuries to this joint came second in frequency in my experience to those of the knee. They were, in fact, comparatively common, especially in conjunction with fractures of the various bony prominences surrounding the articulation. Fractures of the lower end of the humerus were of worse prognostic significance than those of the ulna, on account of the greater tendency to splintering of the bone. . . . Several cases of suppuration which came under my notice did well."

Methods.

i. Skin flaps with circular division of muscles—(a) antero-posterior flaps, (b) lateral flaps. ii. Transfixion flaps, usually antero-posterior. iii. Skin and transfixion flaps combined. iv. Circular; or better, the modified circular method. v. Single flap. vi. Teale's method.

i. **Skin Flaps with Circular Division of Muscles.**—This should be made use of in bulky muscular arms.

(a) **ANTERO-POSTERIOR FLAPS.**—The brachial having been controlled,* and the arm supported at a right angle to the body, the surgeon stands outside the right and inside the left limb, with the forefinger and thumb of his left hand marking the site of intended bone-section (Fig. 75). He then enters the knife on the side of the limb farthest from him, carries it first down 3, 3½, or 4 inches, according as he is going to make

* With an Esmarch's bandage usually; in amputation high up, either the axillary must be controlled by elastic tubing applied by a modification of the method given at p. 182, or the subclavian must be controlled by a reliable assistant, or the vessels secured after the manner given at pp. 183, 188. The last, that of Spence, exposing the brachial artery after one flap has been cut, and securing it before going further (p. 188), is the best owing to its simplicity and wide adaptability.

one flap longer than the other or not,* next across the limb, with square edges, and up the side nearest to him, to the point opposite to that from which the incision started. Then passing the knife under the limb, he marks out a posterior flap, usually somewhat shorter than the anterior. These flaps, consisting of skin and fasciæ, are now dissected up, the muscles cut through at the flap-base with a circular sweep, and the bone sawn through as high as possible. Especial care should be taken here, as in forearm amputations, to divide the nerve-trunks square and high up.† In tying the main arteries, each must be thoroughly separated from its accompanying nerve.

(b) **LATERAL FLAPS.**—This method may be made use of, one flap being cut longer than the other, when the skin is more damaged on one side.

The surgeon, standing as before, marks the site of bone-section by

FIG. 74.



(Fergusson.)

placing his left forefinger and thumb, not now on the two borders of the arm, but on the middle of the anterior and posterior surfaces of the limb. Looking over, he enters his knife at the latter spot, and cuts a well-rounded flap, ending on the middle of the anterior aspect, and then from this point, without removing the knife, another flap is marked out by a similar incision ending at the middle of the back of the arm. The flaps are then dissected up, and the operation completed as before.

ii. **Transfixion Flaps, usually Antero-posterior** (Fig. 74).—In an arm of moderate size, or where rapidity is required, as in warfare or in cases of double amputation, this method may be made use of. The objection to it is that it involves the removal of an undue

* If the flaps are cut of equal length, the cicatrix will be opposite, and perhaps adherent to, the bone; this is very undesirable, though of less importance in a stump of the upper than of the lower extremity.

† In an amputation which passes through the musculo-spiral groove, great care must be taken to divide completely the nerve lying in this, before the bone is sawn. The depth of this groove varies much. When it is considerable, the nerve may easily escape division and be frayed by the saw, giving rise, if overlooked, to a most painful, bulbous end.

amount of bone, and, where the amputation is high up, interferes with the preliminary securing of the brachial artery by Spence's method. The surgeon, standing as before,* and with his left hand marking the flap-base, and lifting up the soft parts anterior to the humerus so as to get in front of the brachial vessels, and thus avoid splitting them, sends his knife across the bone and in front of the above vessels, and makes it emerge at a point exactly opposite; he then cuts a well-rounded flap, about 3 inches long, with a quick sawing movement, taking care, after he feels the muscular resistance cease, to carry

FIG. 75.



his knife on a little, so as to cut the skin longer than the muscles, the knife being finally brought out quickly and perpendicularly to the skin. The flap being then lightly raised, without forcible retraction, the knife is passed behind the bone at the base of the wound already made, and a posterior flap cut similar to the anterior, but somewhat shorter. Both flaps are then retracted, any remaining muscular fibres divided with circular sweeps of the knife, and the bone exposed a little

FIG. 76.



above the junction of the flaps. The saw is then applied after careful division of the periosteum. The brachial artery will either be found in the posterior flap, or if, as both flaps are made, the soft parts are drawn a little from the humerus, the main artery and nerves will be left, and must be cut square with the circular sweeps of the knife.

If it be preferred, lateral flaps can be made by transfixion (Fig. 74), one, of course, being cut longer than the other if this is rendered desirable by the condition of the soft parts.

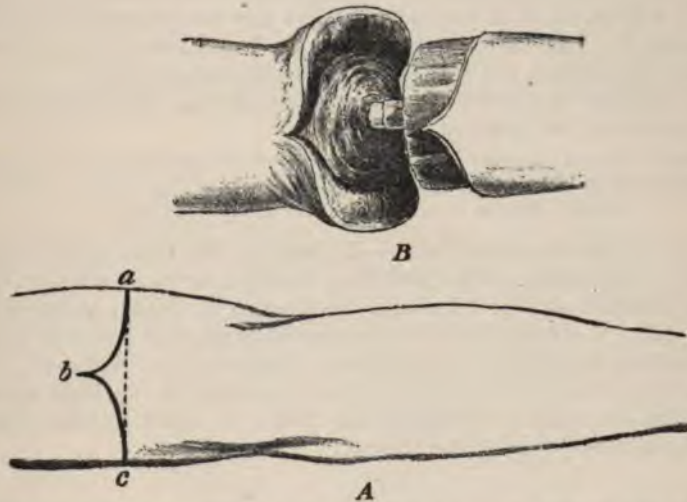
iii. **Combined Skin and Transfixion Flaps** (Fig. 75).—This, a very speedy and efficient method, may be made use of here. An

* In Fig. 74 the surgeon is supposed to be standing outside the left arm.

anterior flap of skin and fasciæ, about 3 inches long, having been marked out (p. 75) and dissected up, the bulk of the soft parts behind the bone are drawn a little away from it, the knife passed behind the humerus, and a posterior flap, somewhat shorter, cut by transfixion.

iv. **Circular** (Fig. 76), or better, the modified circular method (Fig. 77).—Owing to the moderate size of the limb, and its circular

FIG. 77.



Amputation of the arm by the modified circular method. The dotted line *a c* in *A* is the ordinary incision in the circular method, while the thick line *a b c* shows the modified circular incision. The skin flaps are shown in *B* as well as the circular division of the muscles.

Two equal flaps of skin and subcutaneous tissue are cut, their lower limit being, in the case of an ordinary forearm, about $1\frac{1}{2}$ inches below the seat of the circular division of the muscles, and then again about $1\frac{1}{2}$ inches below the point of section of the bones. In the arm each of these measurements will be increased to $2\frac{1}{2}$ inches or more. After the flaps are raised, the muscles are divided by a series of circular sweeps of the knife. After each cut they are firmly retracted until the bone is exposed at the proposed point of division. The periosteum having been divided circularly, it is stripped up with a rugine along with the muscles. Thus, when the bone has been sawn, a cap of periosteum falls over the cut end. The muscles and periosteum must be stripped off the bone together, not separately. (Cheyne and Burghard.)

shape, this is the place, above all others, where this method can be made use of, especially in limbs which are not very bulky. Whether he make use of it in after-life or not, the student should always practise circular amputation here on the dead subject.

Standing as before, or on the outer side of either limb, the surgeon, with his left hand, draws the skin up strongly, and passes his knife under the arm, then above, and so around it, till, by dropping the point vertically, the back of the knife looks towards him, and the heel rests on the part of the arm nearest to him. A circular sweep is then made round the limb, the completion of this being aided by the assistant in

charge of the limb, who should rotate it so as to make the tissues meet the knife. A cuff-like flap of skin and fascia* is then raised, for $2\frac{1}{2}$ or 3 inches, with light touches of the knife, these being especially needed along the lines of the intermuscular septa. In a very muscular arm it may be difficult to raise the skin as directed, and it will be sufficient here for an assistant to retract it evenly all round as it is freed by the knife. When the skin has been sufficiently folded back or retracted, the muscles are cut through close to the reflected skin.† The cut muscles are next retracted by the operator's left hand, and the remaining soft parts, with the main vessels and nerves, are severed clean and square.‡ The bone is then freed for $\frac{3}{4}$ inch, and, the periosteum having been divided, is sawn through as high as possible.

An account of the modified circular method (Fig. 77), which is always to be preferred, is given at p. 96.

v. Single Flap.—This, preferably an anterior, is cut by transfixion, and so arranged, if possible, as not to include the large nerves (Malgaigne).

vi. Teale's Method.—This is, however, expensive of important parts.

Height of Section of the Bone.—If possible, the head of the humerus should be left *in situ*. This not only leaves a far more shapely stump, but, as pointed out by Farabeuf, quoting from Percy, it furnishes a useful point of attachment for an artificial limb, and one well fitted to bear pressure in certain occupations. Farabeuf (*loc. supra cit.*, p. 350) alludes to the necessity of preserving, in amputations high up, some part of the insertion of the pectoralis major in order to counteract the tendency to abduction of the stump.

EXCISION IN CONTINUITY OF THE SHAFT OF THE HUMERUS AND BONE-GRAFTING.

This operation has been especially discussed in reference to gunshot wounds. By the term "excision in continuity," deliberate removal of portions of the shaft of the humerus—*e.g.*, 2–6 inches—the periosteum being preserved as far as possible, is meant; such operations as incision and removal of splinters, operations for necrosis and for pseudoarthrosis, should be excluded.

Dr. Otis§ thus wrote, in 1883, of this operation.

"I cannot discern that the experience of the war lends any support to the doctrine of the justifiability of operations of this nature except in very exceptional cases. The numerical returns, and the necessarily abbreviated summaries, may appear, at first glance, to represent the results in a favourable light, but a more precise analysis reveals

* See footnote, p. 98.

† By some it is advised to cut the biceps rather longer than the rest, owing to its retracting more, as it is not attached to the humerus.

‡ See the remarks (footnote, p. 155) on the importance of securing thorough and clean division of the musculo-spiral nerve when the amputation passes through the groove.

§ *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 695 *et seq.* In Circular No. 3, p. 223, seven "successful" cases are briefly reported. In one of these, two months after the removal of three inches of the shaft (the operation having been performed for caries a year after a gunshot injury), bony union had taken place, and the functions of the hand and arm were well performed. The patient could lift 8 or 10 lbs., and the arm was still becoming stronger. The bone removed is said to have been completely denuded of its periosteum in its entire circumference, this membrane being probably thickened.

most lamentable conclusions. . . . The mortality rate is nearly double that observed in the cases treated by expectant measures, and more than 12 per cent. higher than the fatality in a larger series of primary amputations in the upper third of the arm. Moreover, in the 477 cases of recovery there were no less than 99 instances in which 'no bony union' was reported, and 65 others recorded as examples of 'false joint.' There were also amongst the cases reported as 'successful' 37 instances of consecutive amputation of the arm. Recourse was had to ulterior exarticulation or amputation in 64 patients, of whom 27 perished.

"Such evidence warrants the assertion that early excision in the continuity of the humerus after injury can seldom be justifiable, a conclusion at which European surgeons had already arrived from the experience of the Schleswig-Holstein and Danish wars, and which had been confirmed by more recent observations. The coaptation of the resected ends of the bones by silver wires was sometimes practised, with few illustrations of favourable results. Examination of the details of many of the formal primary excisions in the shaft strengthens the impression that they were for the most part unnecessary and injurious."

Causes of Failure after Excision of the Humerus in Continuity.—Amongst these are :

1. Osteo-myelitis and pyæmia. 2. Secondary hæmorrhage. 3. Secondary necrosis. 4. Non-union, leading to a limb which dangles* or is flail-like, and is more or less useless in spite of a support.

While excision in continuity of the humerus is to be condemned as a primary operation, and while the same operation performed secondarily for necrosis may lead to a limb which is of little use without an artificial support, the following case of Sir W. Macewen's (*Annals of Surgery*, vol. vi. No. 4, p. 301) shows what ingenuity and perseverance may effect in such cases, and proves that detached portions of bone deprived of their periosteum are capable of living and growing after transplantation :

A boy, æt. 2, had complete† necrosis of the shaft of his right humerus after suppurative periostitis. The necrosed bone was removed about nine weeks after the onset of the periostitis, leaving the layer of granulations covering the periosteum intact, and forming a tube, which was kept patent by dressings suitably inserted until the whole space had granulated up. No bone grew from the periosteum, except a small part next the proximal epiphysis where, at the outset, the periosteum was found covered by plaques of adherent osseous tissue. From the whole of the remainder there was no osseous deposition, the result being a flail-like arm. Fifteen months subsequently he returned to the Glasgow Royal Infirmary, his parents desiring that the arm should be removed, it being worse than useless, inasmuch as he required the other hand and arm to look after the flail-like one, which was constantly dangling in the way. The condition of the arm was as follows :—The bone had not increased in length since he left the hospital. When the limb was allowed to hang by the side, the measurement, from the tip of the acromion process to the distal extremity of the humeral shaft, was nearly 2 inches. The proximal fragment was conical, and tapering from the rounded head to a narrow spike-like extremity. From this to the condyles there was a complete absence of bone, there being nothing but soft tissues in the gap. The muscular power was good, but when he attempted to raise his arm a contraction of the muscles took place, the condyles being drawn towards

* There is a good illustration of this result in Fig. 506, *loc. supra cit.*, p. 682. Further details are needed of the amount of use made of, and the ultimate advantage accruing from, the ingenious apparatus of Dr. Hudson, which was supplied to many of these cases.

† Sir W. Macewen points out that it is probable that in the outset of this case the nutrient artery of the humerus was occluded or separated in the intensity of the suppurating process. The periosteum which remained not only did not produce bone, but, fifteen months later, appeared to have been completely absorbed.

the proximal extremity, while some fibres of the deltoid raised the spike-like process of the upper portion, causing it to project as if about to penetrate the skin. Here the action ceased, the soft parts in the gap appearing like a rope during the muscular contraction. He could not raise his forearm to his breast, the lever and fulcrum needed being wanting. It was determined to supply these by transplantation from other human bones. In the wards there were numerous cases of marked anterior tibial curves, from which wedges of bone had to be removed, and these were used as transplants. An incision was made into the upper third of the humerus, exposing the head of the bone. Its extremity, for fully $\frac{1}{4}$ inch, was found to be cartilaginous. The cartilaginous spike-like process was removed, leaving there a portion of bone, which measured $1\frac{3}{4}$ inch from the tip of the acromion. From this point a sulcus, about 2 inches long, was made, downwards, between the muscles. The former presence of bone was nowhere indicated, and there was no vestige of periosteum, the sole guide as to the correct position into which the transplant was to be placed being an anatomical one.* Two wedges of bone were then removed from the tibia of a patient, aged 6, affected with anterior curves. The base of these osseous wedges consisted of the anterior portion of the tibia, along with its periosteum. After removal they were cut into minute fragments with the chisel, quite irrespective of the periosteum. The bulk of the fragments had no periosteum adhering to them, they having been taken from the interior of the bone. They were then deposited in the muscular sulcus in the boy's arm, and the tissues drawn over them and carefully adjusted. The wound healed without pus-production.† Two months after, a portion of bone, 1 inch in length, and $\frac{3}{4}$ inch in thickness, was found firmly attached to the upper fragment of the humerus. In moving the finger from the head of the bone towards the graft, the latter could be easily distinguished by the sudden increase in the breadth. Now, instead of the former sharp spike, the upper fragment ended obtusely. Two other wedges of bone, of larger size than the first, were similarly dealt with, and inserted two months after the first. These filled up the gap in the arm to the extent of $4\frac{1}{2}$ inches, the arm then measuring 6 inches in length. Soon the utility of the arm was greatly restored.

Seven years afterwards the patient was seen and examined. The shaft of the humerus was found to have increased in length by $1\frac{1}{4}$ inch, being $7\frac{3}{4}$ inches; it had increased in circumference to a marked extent, and had assumed a somewhat irregular shape. The patient could use his arm for a great many purposes—taking his food, adjusting his clothes, and in many games.

In some remarks on this case Sir W. Macewen advances the following arguments against the supposition that the new bone grew from old periosteum:—(1) If any of this had existed and possessed osteogenic power, it had ample time to reveal itself by osseous growth during the fifteen months which had elapsed between the removal of the dead bone and the transplantation of the new. (2) In opening the sulcus between the muscles for the reception of the transplants no periosteum or anything like fibrous membrane was seen. (3) The growth of the bone was at first only commensurate with the insertion of the transplants, there being no indication of any osseous growth in the vicinity of these which might have arisen from the supposed stimulation of the periosteum. (4) The solid humerus still retains the irregularities of shape which the transplants were permitted to assume in the tissues.

In the very rare cases in which the shaft of the humerus is to be resected, some time after the subsidence of the original acute disease, one of the following **methods** will suffice. In the first an incision is made, starting in the interval between the deltoid and the great pectoral, and carried down to the lower extremity of the deltoid; at this point it meets the external intermuscular septum, and is now carried more superficially (so as not to injure the musculo-spiral nerve) till it gets

* *I.e.*, the only guide was by recognising the relative positions which the muscles ought to occupy towards the humerus.

† The importance of this statement, and its effect upon the very happy result of the case, will not escape the reader.

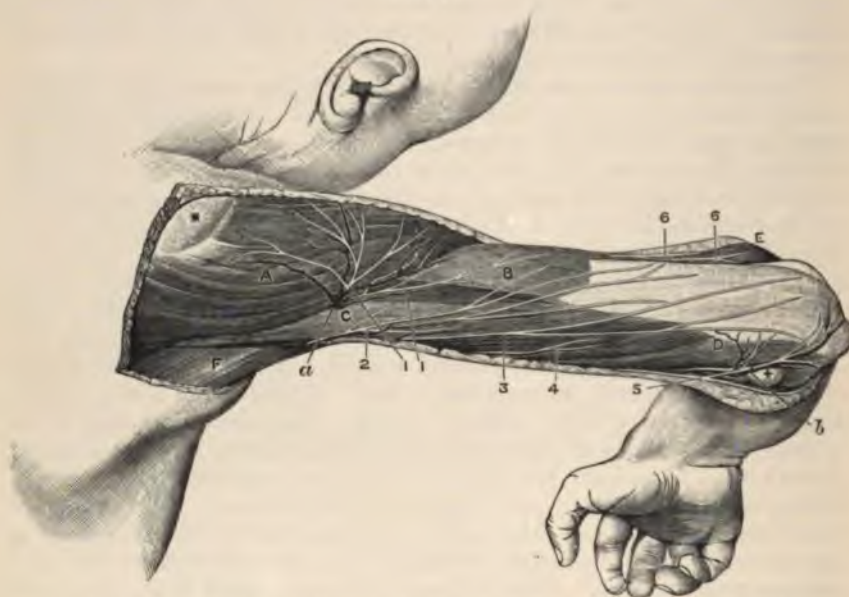
into the interval between the triceps behind and the brachialis anticus and supinator longus in front, whence it is carried down to a point just above the external epicondyle. The nerve is made sure of by opening the intermuscular septum and drawing the triceps backwards and the brachialis anticus forwards, and then held carefully aside with an aneurysm-needle. Another method is known as that by a tunnel. The above incision is made above and below, but interrupted in the centre over the nerve. Through the upper incision the upper part of the humerus is removed, the saw being applied in the lower part of the wound, above the nerve. The lower end of the bone is got out through the lower incision, the saw being now applied below the nerve. The intermediate portion of the bone is now held firmly by lion-forceps and carefully peeled out, periosteal elevators being used in the upper and lower parts of the wound respectively.

Prof. Ollier warns those who would expect that periosteum methodically detached from the bone will always and completely reproduce the bone that it normally covered, that they are under a dangerous illusion. It can only be relied upon to do so in early life in young subjects, and when there has been no infective suppuration destructive to the bone-producing cells, and when some longitudinal splinters have been left attached within the periosteal sheath. A case of Billroth's (*Arch. f. klin. Chir.*, 1877) is quoted, in which, after removal of the whole humerus in a boy of 12, in spite of the easy separation and preservation of the periosteum, there was no reproduction of bone. On any attempt to fix or raise the arm, the limb folded upon itself and shortened, the forearm hanging like a flail. By the aid of a support the hand was rendered very useful. A like disappointing result after removal of the diaphysis of the tibia in acute, infective osteo-periostitis, though to a somewhat less extent, owing to the presence here of two bones, will be familiar to all surgeons of experience. It is very easy and tempting to perform this operation early; a better result is secured by waiting until the damaged periosteum has recovered its vitality and osteo-genetic powers. Prof. Ollier, therefore, urges that, whenever possible, a portion of the diaphysis should be left, and quotes cases of resection for gunshot injuries, by himself and Langenbeck (*loc. supra cit.*, pp. 133, 143), in which good results followed this step.

From my own experience no reliance can be placed on the employment of decalcified bone-chips. Though the wound runs an aseptic course they possess no osteo-genetic power of their own. They fail to cause this in the healthy marrow and periosteum which has been exposed around them. I shall, therefore, describe only bone-grafting in the proper sense of the words. The following account is taken from Messrs. Watson Cheyne, C.B., and Burghard's *Manual of Surgical Treatment*, p. 178: "The part must be aseptic, and therefore it is quite useless to introduce pieces of bone into a wound in which sinuses are still present; before anything of this kind is attempted, the wound must have soundly healed. The operation consists in opening up the soft tissues along the line of the deficient bone down to the periosteum and splitting this in two if it can be recognised, and then introducing pieces of bone from some other patient or from one of the lower animals. Perhaps the most convenient animal to use is a young dog. wing are the steps of the operation. After the skin has

thoroughly purified, a free incision is made over the deficient bone. The thickened remains of the periosteum are incised, and a bed is made for the new bone. The wound is then stuffed with sponges to arrest the bleeding, and covered with gauze dipped in a 1-2000 sublimate solution. It is better not to use a tourniquet, because it gives rise to prolonged after-bleeding, which is apt to separate the bone-grafts from the tissues; the oozing should be allowed to stop before the grafts are inserted. The animal selected is then killed by an assistant and rapidly skinned, the carcase doused with 1-2000 sublimate solution and placed

FIG. 78



A. Deltoid. B. Outer head of triceps. C. Long head. D. Inner head. E. Supinator longus and extensor. F. Latissimus dorsi. a. Superficial branch of posterior circumflex. b. Anastomotic. 1, 1. Cutaneous branches of circumflex. 2. Inter costo-humeral. 3. Internal cutaneous of musculo-spiral. 4. Nerve of Wrisberg. 5. Posterior branch of internal cutaneous. 6. External cutaneous branches of musculo-spiral. * Acromion. + Internal condyle. (Godlee.)

on an aseptic board or tray covered with a carbolised towel. With a fresh sterilised knife and forceps the muscles are rapidly peeled off the bone—the best one for the purpose is the humerus—the periosteum being left undisturbed, and a portion is removed by cutting pliers. The length of the individual grafts is not a matter of much importance; they can be as long as the wound, but they must not be too thick or too broad, and it is well therefore to split the bone longitudinally into fragments with a stout knife. A series of these fragments are laid in the wound after removal of the sponges, until a sufficient amount has been introduced. The skin wound is then closed without a drainage-tube, an antiseptic dressing applied, and the part put on a splint, on

which it is kept at rest sufficiently long for consolidation to occur. If the operation is done aseptically, no infection of the part will take place, and the pieces of bone do not separate; they gradually become welded together and united with the surrounding tissues, and to some extent they lead to the formation of new bone. Unfortunately, in a good many cases, absorption goes on to such an extent that the limb becomes weak again, but in some instances very satisfactory results have been obtained. It is better to use bone from one of the lower animals than from another patient (for example, from an amputated limb) because of the possibility of transmitting disease thereby."

A very successful case of bone-grafting for restoration of the bridge of the nose by Mr. Watson Cheyne, C.B., will be found under the section on "Rhinoplasty" and *Clin. Soc. Trs.*, 1899, vol. xxiii. p. 218. Mr. A. Lane restored the shaft of the ulna in two cases (*Clin. Soc. Trs.*, vol. xxxii. p. 44).

One case was that of a child with congenital mal-development of the bone. The ulna consisted of two separate portions, whose pointed extremities overlapped, and whose axes varied considerably in direction. Both were freely exposed and separated from the adjacent parts. Extension was then made on the lower one till the hand was in the normal position. The femur of a rabbit was then split longitudinally, and its halves wired to the fragments of the ulna (apparently by the encircling method) so as to bring their axes normal and to retain the lower one on a level with the radius. The result was most satisfactory, not only as to the removal of deformity, but also because of the marked and progressive improvement in the usefulness of the limb.

The second case was that of a man, æt. 19, who had lost the shaft of one ulna two years before. A radiograph showed the existence of a fine spiculum between the two extremities of the ulna. An incision exposed the two ends of the ulna and the spicule, and freed them from the adjacent parts. The femur of a very large rabbit was then securely wired to the ends of the ulna. The resulting limb was much stronger than it was before the operation. It is pointed out that in such a case the presence of new bone thrown out at the upper extremity of the ulna, as a result of the original inflammation, and some ankylosis of joints may interfere with a perfect result.

OPERATIONS ON THE MUSCULO-SPIRAL NERVE

(Figs. 78 and 79).

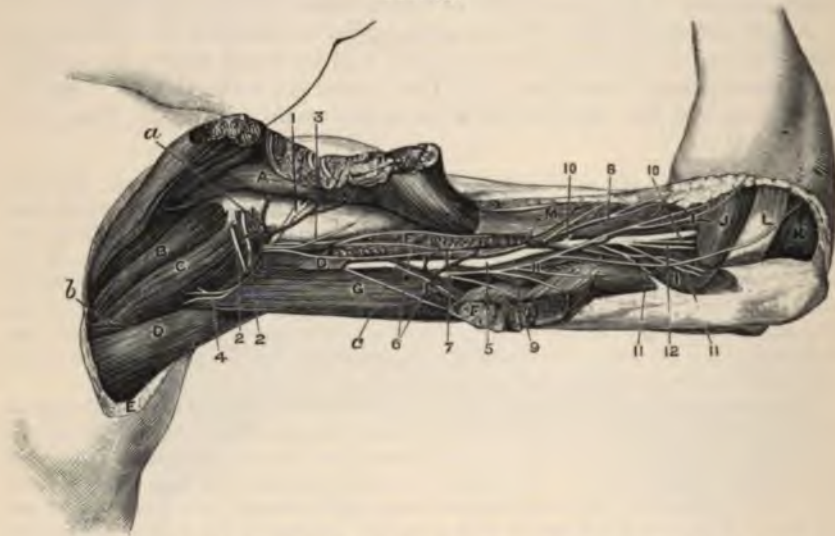
Relief from Compression.—This nerve is, owing to its close connection with the shaft of the humerus, occasionally liable to compression by callus.* M. Ollier many years ago recorded a case of this kind successfully treated by surgery (*Gaz. Hebdomadaire*, 1865, p. 515; *Soc. Bien. Retr.*, 1865—66, p. 294).

A man, aged 22, had suffered a compound fracture of the right humerus, through the musculo-spiral groove. Four months later, the fracture having firmly united, the extensors of the wrist and fingers were completely paralysed, and sensibility along the course of the radial was much diminished. The integrity of the functions of the triceps seemed to show that the lesion must be seated below the commencement at the musculo-spiral groove, where the branches to that muscle are given off. M. Ollier concluded that the nerve was compressed either by one of the fragments or by exuberant callus. Prolonged treatment directed towards the removal of the callus having failed, the patient was submitted to operation. An incision having been made in the presumed direction of the

* The occasional abundance of this callus may, perhaps, be in part accounted for by the ossification of the periosteum of the humerus.

nerve, so as to expose it in the external intermuscular septum, it was found by tracing a branch upwards. A gutter was next cut with chisel and mallet for $1\frac{1}{2}$ inch through the callus, this step exposing the nerve, swollen and hypertrophied in its lower part, and above, strangled (as if by a ligature) by a point of bone apparently belonging to the lower fragment. This point being cut off, and a probe passed behind the nerve to secure its complete isolation, the nerve was then followed for $\frac{1}{4}$ inch above and below the bony canal, so as to ensure its liberation, and, in order to obviate any reproduction of bone, the periosteum was removed all round. The nerve was not disturbed from its gutter, for fear of contusing or

FIG. 79.



A. Deltoid cut and partly turned forwards. B. Infraspinatus. C. Teres minor. DD. Teres major. FF. Outer head of triceps, part of which has been removed. G. Middle head. H. Inner head of triceps. II. Supinator longus, cut, and the upper part reflected. J. Extensor C. radialis longior. K. Anconeus. L. Common origin of extensors. M. Brachialis anticus. a. Posterior circumflex. b. Branch of dorsal scapulae. c. Superior profunda. 1, 2, 2. Branches of circumflex to deltoid. 3. Cutaneous branches of circumflex. 4. Branch to T. minor. 5. Musculo-spiral. 6, 6. Branches to outer head of triceps. 7 and 8. External cutaneous branches of musculo-spiral, the former supplying outer head of triceps. 9. Branch to long head of triceps. 10, 10. Branches of musculo-spiral to brachialis anticus. 11, 11. Branches to supinator longus. 12. Branch to extensor carpi radialis longior. (Godlee.)

stretching it. The wound healed rapidly. From the sixth day the patient experienced some pricking sensations on the back and outer part of the forearm, and sensibility began to increase in the thumb and forefinger. On the twentieth day he could raise his hand a little by voluntary efforts; and when he left the hospital, six months and a half after the operation, he insisted on going back to his work in the fields.

Similar cases have been recorded by M. Trélat, by M. Tillaux (*Traité d'Anatomie Topographique*, p. 511), and by Mr. Puzey,* of

* This surgeon also relates (*Brit. Med. Journ.*, vol. i. 1885, p. 979) a case in which he successfully operated, six months after the injury, in order to set free the ulnar nerve which had been drawn into the callus uniting a compound fracture of the bones of the forearm.

Liverpool (*Brit. Med. Journ.*, vol. ii. 1889, p. 309), in each case with a successful result. The nerve was found either between the two heads of the triceps, or by following it up from its site between the brachialis anticus and supinator longus. In Mr. Puzey's case it had been noted, three months after the fracture, that there was rather an excess of callus present.

Prof. Keen, of Philadelphia, has recorded (*Arch. Intern. de Chirurg.*, vol. i. p. 74) a case in which the nerve was injured after a fracture "at about the surgical neck of the humerus." Complete wrist-drop was discovered when the splints were removed at the end of six weeks. The nerve was found, very much thickened, under the supinator longus, and traced upwards by a free longitudinal incision, with a transverse cut added above, posteriorly, to reach the axilla. The indurated condition and adhesions of the nerve to the bones extended up to this point, and were due to laceration of the tissues by the ends of the bone. The nerve was stretched, and a portion only of the diseased part, 3.7 cm. long, was removed, and the two ends sutured with silk passed directly through the nerve. Sensation began to return immediately, but nine months later, while sensation was perfect, the wrist-drop was still complete. The patient was directed to use the galvanic current for ten or fifteen minutes daily, and injections of $\frac{1}{20}$ gr. of strychnia into the extensors three times a week. Thirteen months later, the patient having carried out the above treatment for three or four months, there was practically complete restoration of function in the extensors, and the hand was perfectly useful, though complete extension, both of fingers and wrist at the same time, was not yet possible. It is noteworthy that while voluntary control had been so well restored, the electrical reactions were practically unchanged, the extensors only reacting to a faradic current so strong as to cause contraction of the flexors also. Dr. Spiller's report on the nerve removed showed profound degeneration. As it was only possible to remove a portion of the diseased nerve, it is doubtful if this step was needful. In the *Medical Chronicle* for August, 1900, Prof. Keen has published six similar cases of secondary suture of the musculo-spiral nerve for wrist-drop. Five of these were due to fracture of the humerus. They teach that the results of neurorrhaphy is frequently not very good. In four of these cases there was little or no improvement, but thirteen years, thirteen months, and twenty-two months had elapsed since the accident in three of them. It is emphasised that mere suture of the nerve will, of itself, do but little good, without systematic massage and electrical treatment carried out persistently for at least a year. In the case in which thirteen years had elapsed since the fracture of the humerus, the nerve was so degenerated that six cm. remained between the healthy ends after nerve-stretching and resection. This gap was bridged over by twelve strands of catgut passed between the two ends. The wound healed rapidly, but there was no improvement in the nerve.

Suture.—Mr. Lucas (*Guy's Hosp. Rep.*, xlv. p. 1) records two cases of division of this nerve by stabs.

In one case, a lad aged 16, the axillary vein and superior profunda were wounded as well, the musculo-spiral nerve was divided, and its lower part torn and notched. The damaged part was cut away, and the ends united by two catgut sutures. Complete recovery followed, about three months after the injury. The other case dated to an injury about two months before. The scar was five inches from the acromion, opposite the insertion of the deltoid, rather behind the line of the humerus on the outer side. On laying bare the nerve it was found that there was a high division into radial and posterior interosseous, the latter being completely severed just after its origin. The musculo-spiral just before its division, and the radial at its commencement, were involved in dense scar tissue. They "were relieved" from this, and the ends of the posterior interosseous after resection were united by fine catgut. The arm gradually improved with three months' galvanism, and a complete cure followed.

CHAPTER VI.

OPERATIONS ON THE AXILLA AND SHOULDER.

LIGATURE OF THE AXILLARY ARTERY

(Figs. 80 to 85).

Indications.

1. Wound of the artery.* 2. Aneurysm of the brachial high up.† The following instructive case (*Lancet*, 1895, vol. i. p. 92) will repay perusal. It (1) enforces the importance of exploring at once a wound near a large artery that has bled "profusely"; (2) it proves, if this step be not taken and a traumatic aneurysm arise, how much the old operation of tying the vessel above and below the aneurysm and emptying the latter of clot is to be preferred to the Hunterian method;‡ and (3) it is an interesting instance that gangrene, which is by no means unknown in the lower limb after ligature of the external iliac (*q.v.*), may also occur in the upper extremity with its better collateral supply.

A man, æt. 30, accidentally stabbed himself in the outer aspect of the right arm, in its middle third. Profuse hæmorrhage followed. The wound was cleansed and dressed antiseptically, and the arm was bandaged from the hand upwards. The patient was sent home, but at night severe bleeding again set in. This was arrested by "plugging." The following night hæmorrhage recurred, and was again arrested by plugging. The wound gradually healed, and, three weeks later, a circumscribed traumatic aneurysm of the brachial artery developed at "the seat of the original wound, but on a higher level." The aneurysm increased rapidly, soon occupying the whole of the inner and anterior aspect of the upper arm, causing œdema and loss of sensation of the hand and fingers. About fourteen days later, pressure having failed, it was decided to tie the axillary artery in its third part. This cured the aneurysm, but gangrene§ of the thumb, together with sloughing of the tendons of the forefinger, commenced thirty hours afterwards. Amputation

* In some wounds of the artery, the surrounding parts—*e.g.*, veins and nerves—may be so injured, that the vitality of the limb is impaired beyond what ligature and nerve-suture can do, and the advisability of amputating at the shoulder-joint must be considered.

† Dr. Holt (*Amer. Journ. Med. Sci.*, April, 1882, p. 385) mentions a case of aneurysm of the right brachial at its upper third, treated by ligature of the axillary in its lower third. Secondary hæmorrhage supervened; the axillary artery was then tied in its upper third, and a cure followed.

‡ It is always invidious to criticise cases, especially those which the writer has not seen, and it is only fair to the surgeon who publishes this case to quote his words. "The only alternative would have been to open the aneurysm, turn out the contents, and attempt to tie both ends of the artery, an operation fraught with great danger to the limb and to the patient in his then weakened condition."

§ In this case the repeated bleeding had reduced the size of the main vessel (as in the case mentioned at p. 152) and its anastomoses. Ligature of the axillary artery, very probably, further cut off the blood supply through one of the most important collaterals—*viz.*, the superior profunda (p. 150).

of the thumb at the metacarpo-phalangeal joint was required later on, and the index finger remained stiff.

More rarely still—3. As a distal operation for aneurysm of the subclavian. 4. Very occasionally, as the old operation after rupture of the axillary artery in shoulder dislocations (p. 133). 5. Very occasionally, as the old operation for axillary aneurysm (p. 133). 6. For hæmorrhage from malignant disease in the axilla.

This last is extremely rare, but a good instance, and one showing the difficulties which may be present, was published by Sir W. Savory (*Med. Chir. Trans.*, vol. lxix. p. 157). Injury to the axillary vessels during removal of the breast is dealt with under this heading.

The following results of injuries from modern bullets to the axillary artery are given by Mr. G. H. Makins, C.B. (*Surgical Experiences in South Africa, 1899-1900*). *External primary hæmorrhage* from the great vessels of the limbs or even of the neck proved responsible for a remarkably small proportion of the deaths on the battlefield. Only one case of rapid death due to bleeding from a limb artery was recounted to Mr. Makins. In this a wound of the first part of the axillary artery proved fatal in the twenty minutes occupied by the removal of the patient to the dressing station. With regard to the treatment of primary hæmorrhage, while the readiness with which spontaneous cessation of hæmorrhage from small calibre wounds was secured was very marked, the frequency with which traumatic aneurysms of every variety followed shows that the ultimate result is in many such cases by no means satisfactory. "Under the circumstances it may be said that the classical rule of ligation at the point of injury should never be disregarded. Against this, however, certain objections may be at once raised; thus, in many cases both artery and vein need ligation, a consideration of much importance in the case of such vessels as the carotid and femoral arteries. . . . On the whole it seems clear that the military surgeon must be guided by circumstances, since it may be far better to risk the chances of recurrent hæmorrhage or the development of an aneurysm or varix, than those of gangrene of a limb, or softening of the brain. As a general rule, therefore, on the field or in a field-hospital, primary ligation of the great vessels is best reserved for those cases only in which hæmorrhage persists, while in those in which spontaneous cessation has occurred, or in which bleeding is readily controlled by pressure, rest and an expectant attitude are to be preferred." *Secondary hæmorrhage* in simple wounds by small calibre bullets was decidedly rare: in compound fractures, especially of the "explosive" kind, it was not uncommon. Lesions of vessels short of perforation, but causing devitalisation of the walls, perforation by a sharp spicule of bone, and, in the large majority, sepsis and suppuration were the chief causes. The treatment to be adopted depends on the nature of the case. When the wound is aseptic and bleeding, the result of separation of sloughs (this was found to be very tardy in aseptic wounds), local ligation is the proper treatment. In septic cases, on the other hand, it is usually far better to amputate, unless the general state of the patient and the local conditions are especially favourable. When neither amputation nor local ligation is practicable, proximal ligation may be of use. Thus one case is given in which ligation of the common carotid was successful for hæmorrhage from an arterial hæmatoma in connection with the internal maxillary artery. *Traumatic aneurysms*. "The experience of the campaign fully bears out that of the past as to the steady increase of the number of aneurysms from gunshot wounds in direct ratio to diminution in the size of the projectiles employed. Every variety was met with, and most frequently of all, perhaps, aneurysmal varices and varicose aneurysms. The following are instances of traumatic aneurysms of this region. *False traumatic aneurysms or aneurysmal hæmatoma* of the axillary artery. Entrance wound in posterior fold of axilla, exit $1\frac{1}{2}$ inches below the junction of the anterior fold with the arm. The man rode four miles after being hit, but the horse then fell and rolled over him twice. The wound healed, but the whole upper arm was swollen and discoloured, while an indurated mass extended along the vessels into the axilla. This was not obviously distensible, and pulsation was very slight. The pulses below were absent. A fluctuating swelling was present along the

anterior border of the deltoid. Tactile anæsthesia existed in the area of the median nerve. On the thirty-first day considerable enlargement was noticed. This, together with continued rise of temperature, aroused the suspicion of suppuration, and an exploratory puncture was made by Major Longheed, R.A.M.C., after consultation with Prof. Chiene. Clot, followed by profuse hæmorrhage, escaped. The incision was enlarged, while compression of the third part of the subclavian was maintained, and an oval wound half an inch long was found in the axillary artery. Ligatures were applied above and below the opening between the converging heads of the median nerve. All the swelling disappeared with the healing of the wound, but the diminished median tactile sensation persisted. A somewhat similar case, but one of true traumatic aneurysm, treated by double ligature of third part of the axillary artery, came under my care in the spring of 1902, at Guy's Hospital. The patient had been shot through the inner and upper part of the pectoral region, the wound of exit being in the posterior fold. He received the wound in one of the night attacks on our camps, and his assailant was so close that he killed him by a snap-shot with his rifle resting on his thigh. Both wounds healed by first intention, and he came to me for diminished tactile sensation over the area of the musculo-spiral. The radial pulse was normal, and there was nothing to call attention to the existence of an aneurysm. I should state, however, that a bruit was not listened for. The musculo-spiral nerve, which alone appeared damaged, was explored by an incision along the axillary vessels, with partial division of the great pectoral. No damage could be found in the course of the nerve, but, as it was traced upwards, a small ovoid sac of a traumatic aneurysm was found between the two heads of the median nerve. Ligatures were placed above and below, the aneurysm opened, and some old clot turned out. Owing to the intimate association of the nerve it seemed wiser not to try and remove the aneurysm. It was hoped that any pressure which the aneurysm might be making on the nerve would gradually diminish with the shrinking of the opened sac. This, however, was not realised. When the patient left the hospital there was no evidence of recovery of the diminished tactile sensation over the musculo-spiral area. A very similar case is given by Mr. Makins, (*loc. supra cit.*, p. 129). The Mauser bullet entered $2\frac{1}{2}$ inches below the acromial end of the right clavicle, and emerged over the ninth rib in the posterior axillary line. Three weeks later, the wounds being healed, a large arterial pulsating hæmatoma was noted in the axilla. Signs of injury to the musculo-spiral were also observed. The swelling altering little, Major Burton, R.A.M.C., cut down upon it through the pectorals a fortnight later. The aneurysm was of the third part of the axillary, and a ligature was applied at the lower margin of the pectoralis minor. The wound healed by primary union, and when the man left for England a month later, the musculo-spiral paralysis was improving. *Aneurysmal varix and varicose aneurysm.* The frequency with which these occurred and the larger proportion of the latter has already been alluded to. With regard to treatment Mr. Makins (p. 145) warns us that "while modern surgery has lightened the difficulties under which our predecessors approached these operations, none the less the experience of this campaign fully supports the objection to indiscriminate and ill-timed surgical interference, as accidents have followed both direct local and proximal ligature." The following are Mr. Makins's chief conclusions: In *aneurysmal varix* there should be no interference in the early stage, in the absence of symptoms. "In many cases an expectant attitude may lead to the conviction that no interference is necessary, especially in certain situations where the danger of gangrene has been fully demonstrated. In connection with this subject Mr. Makins relates two cases in which an aneurysmal varix, in one patient of the femoral vessels, in the other of the axillary, had existed for years, and had not interfered with the patient's work. In the second case, after twenty years' existence of the varix, the patient as a combatant in South Africa was subjected to very hard manual work. This brought about increase in size, cervico-brachial neuralgia, &c., and in consequence, the man was invalided. (2) The arteries of the upper extremity are the most suitable for operation, and the axillary may, perhaps, be the vessel in which interference is most likely to be useful. The vessels of the arm and forearm may in almost all cases be interfered with, but in many instances an absence of any serious symptom renders operation unnecessary. (3) The operation most in favour consists in ligature of the artery above and below the varix, the vein remaining untouched. . . . Failure is due to the presence of collateral branches, which are not easy of detection. Even when the vessels lie exposed, the even

distribution of the thrill renders determination of the exact point of communication difficult, and the difficulty is augmented by the temporary arrest of the thrill following the application of a proximal ligature. . . . If the vein cannot be spared, excision of a limited part of both vessels may be preferable, especially in those of the upper extremity." Single ligature or proximal ligature is useless in aneurysmal varix. (4) "Given suitable surroundings and certain diagnosis, the ideal treatment of this condition, as of the next, is preventive—*i.e.*, primary ligature of the wounded artery. Many difficulties, however, lie in the way of this beyond mere unsatisfactory surroundings. It suffices to mention the two chief: uncertainty as to the vessel wounded, and the necessity of always ligaturing the vein as well as the artery in a limb often dissected up by extravasated blood, to show that this will never be resorted to as routine treatment." (5) *Arterio-venous aneurysm*. Many of the above remarks find equal application here, but in the presence of an aneurysmal sac non-intervention is rarely possible or advisable. . . . In the early stages the proper treatment in any case consists in as complete a position of rest as possible, and affording local support to a limb by a splint, preferably a removable plaster of Paris case. Should no

FIG. 80.



Parts concerned in ligature of the first part of the (left) axillary artery: 1 and 2, Cut edges of the clavicular attachment of the pectoralis major. 3, Subclavius. 4, Axillary vein. 5, Sheath of subclavius, which, depressed, has partly concealed 6 (the cephalic vein), seen to the right. 7, Axillary artery. 8, Nerve to pectoralis major. 9, Cords of brachial plexus. (Farabeuf.)

further extension, or what is more likely, should contraction and diminution occur, it will be well to continue this treatment for some weeks at least. When the aneurysm has reached a quiescent stage, the question of further treatment arises, and whether this should consist in local interference or proximal ligature. . . . In the case of arterio-venous aneurysms in the limbs the possibilities of treatment are enlarged, and here the alternatives of (a) local interference with the sac and direct ligature of the wounded point, (b) simple ligature above and below the sac, (c) proximal ligature (Hunterian operation) present themselves.

Mr. Makins's opinion is strongly "to the effect that none of these operations should be undertaken before a period of from two to three months after the injury, unless there is evidence of progressive enlargement. In every case which came under my own observation, progressive contraction and consolidation took place up to a certain point under the influence of rest. When this process has become stationary, and the surrounding tissues have regained to a great extent their normal condition, the operations are far easier, and beyond this more likely to be followed by success."

Writing five years later in a paper (*Journal of the Royal Army Medical Corps*, June, 1905), in which a later history of several of his cases of arterio-venous aneurysm are given, Mr. Makins, speaking of operative treatment generally, says: "A ligature placed as near as possible above the aneurysmal sac has been shown to be safe, to afford a reasonable prospect of cure, and not to prejudice a further operation, should this become necessary." And with more especial reference to the arteries

of the upper extremity, the same authority writes: "My personal experience of published cases show that a proximal ligature may with safety and a good chance of success be applied to the vessels above the elbow, and for wounds at the elbow itself, this procedure is to be generally preferred. In the midarm a local operation is simple, and in the forearm the same may be said. In either of the latter situations a local is to be preferred to a proximal operation, as

FIG. 81.



Relations of subclavian and axillary arteries. The sterno-mastoid, trapezius, and omo-hyoid are seen above. The blunt hook draws outwards the external jugular, which is falling into the subclavian vein. The artery is seen emerging from beneath the scalenus anticus, below the nerves. Two arterial branches pass outwards—the one close to the clavicle, the supra-scapular; the other, higher up, the posterior scapular, or transverse cervical. Below are seen the deltoid the subclavian, a blunt hook depressing the clavicular part of the pectoralis major, the coracoid process, the lesser pectoral, and the lower part of the costo-coracoid membrane. Another hook depresses the cephalic vein, and exposes the artery, which here gives off its acromio-thoracic branch. (Farabeuf.)

more nearly approaching the ideal and necessitating no obvious risks."

Operations.—Ligature of the first and the third parts of the artery will be first described, and then the old operation.

i. **Ligature of the First Part** (Figs. 80, 81, 82 and 84).—This operation is very rarely performed on the living subject. Owing to the depth of the vessel here, its most important and intimate surroundings, and the risk of secondary hæmorrhage from the vessels which lie so close to the knot, ligature of the third part of the subclavian is preferred if ligature be required for axillary aneurysm. On

the dead subject the student should always take the opportunity of tying the first part of the axillary, as it is an excellent test of anatomical knowledge and practical skill.

LINE.—From the centre of the clavicle (with the arm drawn from the side) to the inner margin of the coraco-brachialis.

GUIDE.—The above line, and the inner margin of the coraco-brachialis.

RELATIONS :—**IN FRONT.**

Skin ; fasciæ ; fibres of platysma. Supra-clavicular nerve.
Pectoralis major (with muscular branches).
Costo-coracoid membrane.
Cephalic vein. Acromio-thoracic vessels.

OUTSIDE.

Outer and inner cords
of brachial plexus.

Axillary artery,
first part.

INSIDE.

Axillary vein.

BEHIND.

First digitation of serratus magnus.
First intercostal space and muscle.
Posterior thoracic nerve.

Collateral Circulation (Fig. 73) :

(a) If the artery be tied in its first part, and the ligature be placed above the acromio-thoracic, the vessels concerned will be the same as those which carry on the blood-supply after ligature of the third part of the subclavian (*q.v.*).

(b) If the artery be tied in its third part, and the ligature be placed below the circumflex arteries, the anastomosing vessels will be the same as after ligature of the brachial above the superior profunda (p. 150).

(c) If the artery be tied in its third part, and the ligature be placed between the subscapular and circumflex arteries, the chief vessels concerned are :

ABOVE.

The supra-scapular }
The acromio-thoracic }

with

BELOW.

The posterior circumflex.

(d) If in tying the third part of the artery the ligature be placed above the subscapular, the anastomoses are more numerous—viz., in addition to those just given :

ABOVE.

The supra-scapular }
The posterior scapular }

with

BELOW.

The subscapular.

Operation.—The vessel may be secured in the following ways. The second is recommended.

A. By a curved incision below the clavicle.—This gives the necessary room, but has the disadvantage of dividing the pectoralis major and its large muscular branches.

B. By an incision in the interval between the pectoralis major and deltoid (Fig. 82).—This method scarcely gives sufficient room, especially if the parts are displaced by effused blood, &c., and it is well to

supplement the incision in the interval by one partly detaching the pectoralis from the clavicle. While this plan involves less hæmorrhage from the pectoralis major, care must be taken to avoid the cephalic vein and acromio-thoracic branches which lie in this interval. This end is best secured, whichever method be adopted, by going down on the artery as close to the clavicle as possible, the sheath of the subclavius being opened, and some of its fibres detached, if needful.

C. By an incision in the line of the artery, viz., one $3\frac{1}{2}$ –4 inches long, starting from just outside the centre of the clavicle, and passing down-

FIG. 82.



Part of the clavicular origin of the pectoralis major has been turned inwards with the flap of skin. The costo-coracoid membrane is seen cut above and below the artery, in the latter case being turned down over the pectoralis minor.

The cephalic vein runs up along the inner edge of the deltoid; a second vein lies on the cords of the brachial plexus above the artery, while others cross the upper part of the wound. A small portion of the artery has been cleaned.

wards and outwards.—This has the disadvantage of cutting the muscular branches to the pectoralis major, and gives less space than the first two.

A. The limb being at first abducted, the surgeon, standing between it and the body, which is brought to the edge of the table, makes a curved incision, with its convexity downwards and about $\frac{1}{2}$ inch from the clavicle, reaching from just outside the sterno-clavicular joint to the coracoid process, the knife being used lightly at the outer end of the incision, so as to avoid wounding the cephalic vein and branches of the acromio-thoracic vessels. The clavicular origin of the pectoralis major is then divided in the whole extent of the wound, and any muscular branches which require it tied or twisted at once. The cellular tissue beneath the muscle being next explored with the tip of the finger and director, the upper border of the pectoralis minor is defined, and this muscle drawn downwards. The costo-coracoid

membrane must next be most carefully torn through close to the coracoid process, which is a good guide, by means of a fine-pointed steel director, the cephalic vein and acromio-thoracic vessels being most scrupulously avoided. The wound all this time must be kept dry, and, if needful, a large laryngeal mirror or an electric lamp may be usefully employed in throwing light into the bottom of the deep wound. The pulsation of the artery being felt for in the living, and its flattened cord-like feel made out in the dead subject, the sheath is exposed,* and the vessel itself carefully cleaned and separated from the vein, which lies below and in front, and from the brachial cords, which are

* The parts may now be advantageously relaxed by adducting the arm.

above the artery. The needle should be passed from below so as to avoid the vein.*

B. By an incision made between the pectoralis major and deltoid (Fig. 82). The limb and the surgeon being in the same position as in the operation just given, an incision is made obliquely downwards and outwards between the above muscles, commencing at the clavicle opposite to the coracoid process. Care being taken to avoid the cephalic vein and branches of the acromio-thoracic vessels, the muscles are separated, and, to gain more room,† a transverse incision is made running inwards along the lower border of the clavicle, and detaching as much as is required of the clavicular origin of the pectoralis major. This flap can be turned inwards and downwards without any interference with the nerve-supply of the muscle, and, owing to its division high up, less hæmorrhage is met with by this method. The deltoid being strongly drawn outwards with a retractor, the upper border of the pectoralis minor is defined, and the operation completed as in the account already given, the parts being relaxed at this stage by adduction of the arm.

ii. Ligature of the Third Part of the Axillary Artery (Fig. 83).

LINE.—From the centre of the clavicle, with the arm drawn from the side, to the inner margin of the coraco-brachialis.

GUIDE.—1. The above line. 2. A line drawn from the junction of the middle and anterior thirds of the axilla, along the inner border of the coraco-brachialis (Fig. 83).

RELATIONS :—

IN FRONT.

Skin ; fasciæ.
Pectoralis major (at first).

OUTSIDE.

Musculo-cutaneous, median. Inner border of coraco-brachialis.

Axillary artery, third part.

INSIDE.

Internal cutaneous ; ulnar.
Axillary vein or venæ comites.

BEHIND.

Subscapularis. Latissimus dorsi. Teres major.
Circumflex nerve. Musculo-spiral.

Operation (Fig. 83).—This resembles somewhat that for ligature of the brachial in the middle of the arm. As with the brachial, so with the axillary here ; though the vessel is comparatively superficial, it is not an easy one to hit off at once, owing to the numerous surrounding nerves, which may resemble the artery closely, especially if blood-stained.

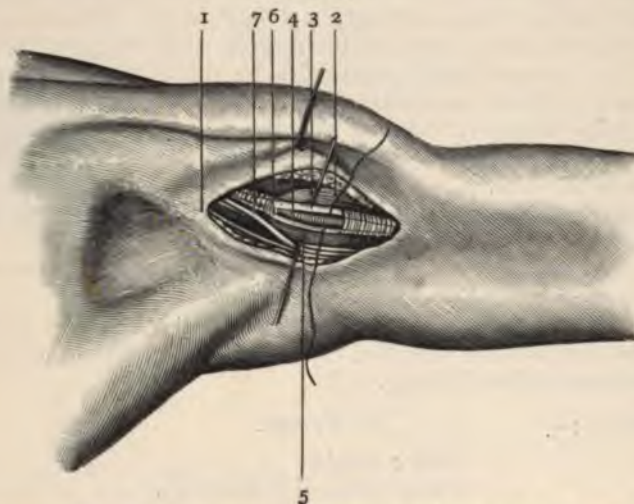
The axilla having been shaved and thoroughly cleansed (p. 127), the arm being extended from the side and rotated slightly outwards (not too forcibly, as this will alter the relations), the surgeon, sitting between the limb and the trunk, makes an incision 3 inches long, at the

* The patient must be prepared for probably weakened or limited use of the limb for some time, at least, after the main arterial trunk has been ligatured.

† This step was advocated by Mr. Rivington (*Brit. Med. Journ.*, 1885, vol. i. p. 1040).

junction of the anterior and middle thirds of the space along the inner border of the coraco-brachialis (Fig. 83). The incision may be begun above or below, as is most convenient. Skin and fasciæ being divided, and the point of a director used more deeply, the coraco-brachialis is identified, and the axillary vein and the median nerve are distinguished from the artery, the former drawn inwards, and the latter, together with the coraco-brachialis, outwards.* The artery is then made sure of, cleaned, and the needle passed from within outwards, the neighbourhood of any large branch, such as the subscapular or the circumflex,

FIG. 83.



Ligature of third part of (left) axillary artery. 1, Axilla at the junction of its middle and anterior thirds. 2, Coraco-brachialis, and above it biceps. 3, Median nerve. 4, Axillary artery. 5, Axillary vein. 6, Internal cutaneous nerve. 7, Ulnar nerve hooked downwards.

being avoided, and the needle being kept very close to the artery. Instead of one axillary vein, two venæ comites, and the basilic as well, may be present.

iii. **Old Operation of Ligature of the Axillary Artery for some Cases of Axillary Aneurysm and Injured Axillary Artery.**—This method may be made use of in the following instances:

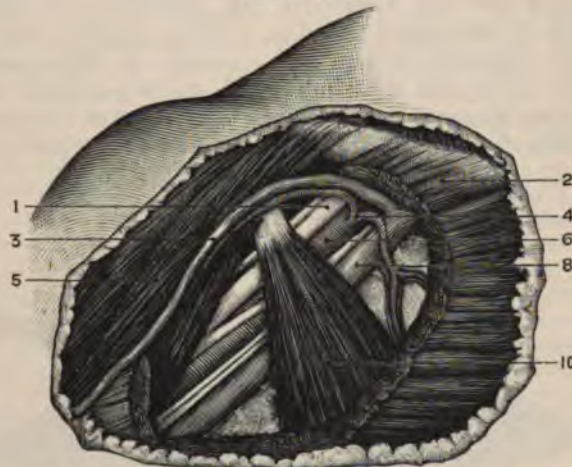
1. Where pressure has failed in the above cases. 2. Where pressure is unsuitable owing to the rapid increase, and large size, of the aneurysm; the condition of the parts over it; or the inability of the patient to bear

* Farabœuf (*loc. supra cit.*, p. 44) gives the following directions for making sure of the artery: Make an incision running just behind the anterior wall of the axilla. Identify the coraco-brachialis by opening its sheath. Draw it outwards, and, with the finger of the left hand sunk in the wound, depress the whole bundle of vessels and nerves. The first cord which escapes upwards, when the finger is withdrawn a little, is free, perforating no muscles: this is the median. Isolate it and have it drawn outwards with the coraco-brachialis. The second large cord, uncovered by withdrawing the first, is the artery.

pain. 3. Where, owing to the displacement of the clavicle, ligature of the subclavian is not likely to be practicable, or where the condition of the coverings of the aneurysm is such that this step, even if carried out, will not avert suppuration, sloughing, &c.

Prof. Syme (*Observations in Clinical Surgery*, p. 140 *et seq.*), holding that the old method would certainly remedy cases not amenable to ligature of the subclavian, and that even in cases where the latter

FIG. 84.



Anatomy of the parts concerned in ligature of the axillary artery. (Heath.)
 1, The outer head of the median, and, external to it, the musculo-cutaneous nerve. Internal to the artery is the inner head of the median, which crosses it below the pectoralis minor, 10. Internal to the artery at this level are the internal cutaneous and the ulnar nerves. 2, Pectoralis major. 3, Cephalic vein. 4, Humeral and pectoral branches of the acromio-thoracic artery. 5, Deltoid. Under this is seen part of the coraco-brachialis and biceps. 6, Axillary artery. 8, Axillary vein.

is practicable the former might be preferable, made use of it in three cases.

In the first case, the skin in the neighbourhood of the shoulder-joint was dusky red and vesicating, and the patient beginning to wander in his mind. In the third, after the operation, delirium tremens set in, with excessive suppuration and sloughing of the tissues of the limb. All three patients recovered, though in age 50, 47, and about 50 respectively.

The following is the account of the operation in Prof. Syme's words (*loc. supra cit.*, p. 148):

"I made an incision along the outer edge of the sterno-mastoid through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian lies upon the first rib. I then opened the tumour,* when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and

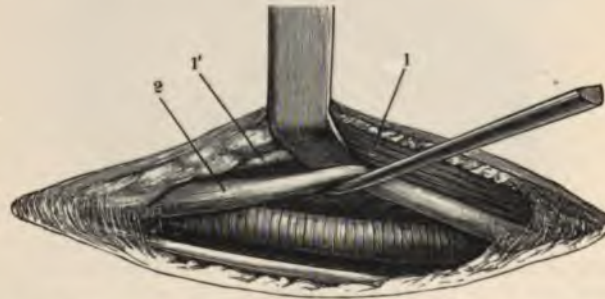
* In one of his cases, while laying open the cavity, Prof. Syme had to avoid the radial nerve, which ran over the surface of the sac.

through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly seven pounds of coagulated blood. The axillary artery appeared to have been torn across, and, as the lower orifice still bled freely, I tied it in the first instance, next cut through the lesser pectoral muscle close up to the clavicle, and, holding the upper end of the vessel between my finger and thumb, passed an aneurysm-needle so as to apply a ligature about $\frac{1}{2}$ inch above the orifice. The extreme elevation of the clavicle, which rendered the artery so inaccessible from above, of course facilitated this procedure from below. Everything went on favourably afterwards."

Sir J. Paget and Mr. Callender (*St. Bartholomew's Hosp. Rep.*, vol. ii.) made a **—** shaped incision, cutting parallel with the lower margin of the pectoralis major, and a second, at right angles to the first, straight up through the whole width of the pectoralis major.

The following case under the care of Dr. N. Raw, of Liverpool (*Liverpool Med.-Chir. Journ.*, July 1899, p. 328), teaches a point which may

FIG. 85.



Parts seen in ligature of the third part of the (left) axillary artery, dissected. The flat retractor raises (1) the coraco-brachialis, the first guide, together with (1') the musculo-cutaneous nerve entering it. The blunt hook draws aside (2) the median nerve, the second guide. Below the axillary artery is seen the small internal cutaneous nerve, which, like the axillary vein and the other large nerve-trunks, is often not seen. Just above the artery, in the depth of the wound, is seen one of the *venæ comites*. (Farabeuf.)

be most valuable in the treatment of these rare but very grave cases—viz., putting a *temporary* ligature round the axillary artery until it is certain whether both this and the vein have given way.

The patient was aged 45, and, five weeks after a dislocation of the humerus had been reduced, a surgeon had manipulated the arm with his heel in the axilla. The arm began to swell the same night. There was slight pulsation in both radial and ulnar arteries. As the accumulation of symptoms had been gradual, rupture of the axillary vein was diagnosed. The swelling increased, and burst with serious loss of blood. An incision was made from the clavicle to the anterior fold of the axilla, dividing the pectoral muscles. The axillary vessels were ligatured under the clavicle, the artery with a temporary ligature. The incision was then prolonged through to the axilla, down the inner side of the arm to the elbow, and several pounds of clot turned out. The axillary vein was found torn completely across, and was tied at both ends; arterial blood was seen to be flowing, and the subscapular artery was found cut across about one inch from the main trunk, and tied. The temporary ligature was then removed from the first part of the axillary artery, and followed by redness and warmth in the limb, but no pulsation in the radial artery. The patient made an excellent recovery, and, six months later, had a fairly useful limb.

A short space may be allotted here to that most important accident which has happened to so many surgeons—viz., rupture of the axillary artery while dislocations of the shoulder are being reduced.

This accident has greatly decreased in frequency of late years owing to the advantages of anaesthetics and the earlier date at which patients apply for treatment. Dr. Stimson (*Ann. of Surg.*, Nov. 1885) draws the following conclusions from forty-four cases, conclusions which modern surgery and an earlier resort to the use of the double ligature may considerably modify:—"Conservative treatment—viz., complete rest with direct pressure—may properly be tried at first, especially if the tumour is small, recent, and not increasing, but should not be prolonged if the symptoms do not promptly yield; and secondly, in case of resort to operation, ligature of the subclavian or disarticulation at the shoulder is to be preferred to incision of the sac and double ligature of the artery." Of seven cases of double ligature of the artery, all were fatal. Of fourteen of ligature of the subclavian, five recovered. Without operation, thirteen died, six recovered. Of four cases of amputation at the shoulder, only one recovered. Repeated puncture is always fatal. Körte, of Berlin (*Arch. f. klin. Chir.*, Bd. xxvii. Hft. 3, quoted by Dr. Stimson), is of opinion that in many cases the injury to the artery is caused at the time of the accident, but hæmorrhage does not come on till after reduction is brought about, as the vessel is compressed by the head of the bone. As to the exact cause of the injury to the vessel when it takes place at the time of the reduction, it is probable that some special condition exists to account for it, as many old dislocations are reduced with much force, used with impunity, —e.g., atheroma; adhesion of the artery to the head of the bone; too great or misapplied force in reduction, viz., use of the boot, in elevation; projection of a fragment or a spicule of bone. It is usually the axillary artery, or one of its branches, which gives way; much more rarely (four out of forty-four cases), the axillary vein.

AMPUTATION AT THE SHOULDER-JOINT.

Indications.

i. Compound comminuted fractures—e.g., railway and machinery accidents.

ii. Gunshot injuries.—Amputation here is divided by Dr. Otis* into (1) Primary, or before the third day; (2) Intermediate, or cases in which the operation was performed between the third and the thirtieth days; and (3) Secondary, in which the operation was performed later than the thirtieth day.

(1) Primary.—The mortality here was 24 per cent. The indications for amputation so soon after the injury are chiefly—(a) A limb torn off partially, but too high to admit of any other amputation; (b) Severe comminuted fracture of the upper end of the humerus, with extensive injury to the vessels and nerves; (c) Such a fracture high up, with severe splintering extending down below the insertions of the pectoralis major and the latissimus dorsi.† (2) Intermediate.—The mortality here, 45 per cent., was nearly double that of the primary. This seems to have been brought about largely by the fact that the operation was now performed through soft parts, the seat, at this time, of unhealthy inflammation, and thus prone to lead to secondary hæmorrhage, pyæmia, sloughing, &c. (3) Secondary.—The causes for this deferred operation were chiefly hæmorrhage, gangrene, profuse suppuration, hopeless disease of the humerus, sometimes with consecutive implication of the joint, chronic osteo-myelitis, or necrosis of the entire humerus. The mortality was 28 per

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 613 *et seq.*

† In some of these the adoption of the Furneaux Jordan method (p. 191) might lead to diminished loss of blood.

cent. From the above it is evident that the necessary examination should be made, and the operation performed, as soon after the injury as possible, consistent with the state of the patient; the difference between operating in sound and diseased parts, and the neighbourhood of the joint to the chest, if an infective condition of the wound sets in, being borne in mind.

iii. New growths.—If these involve the scapula or its processes, the upper extremity should be removed by the method of interscapulo-thoracic amputation (pp. 215, 221). The question of the possibility of saving the limb and removing the growth by excision of the head of the humerus is considered at p. 199.

iv. Disease of the shoulder-joint unsuited for, or persisting after failure of, excision.

v. For osteo-myelitis and necrosis of humerus resisting other treatment, or complicated with early blood-poisoning.

vi. For rapidly spreading gangrene or gangrenous cellulitis with threatening septicæmia.

Mr. C. Heath (*Clin. Soc. Trans.*, vol. xiv. p. 114) recorded such a case in which this amputation was needed to save life.

A nurse had pricked her finger deeply with a pin hidden in some of the clothes of a lady who had died of violent puerperal septicæmia; gangrenous cellulitis rapidly set in, and extended in spite of incisions: on the sixth day the gangrene appeared to be arrested in the forearm, though there was a blush of advancing mischief up the arm. In the afternoon of the same day sudden extension took place, and Mr. Heath removed the arm at the shoulder-joint, the patient ultimately making a good recovery.

The operation chosen was by outer and inner flaps, the former giving a fairly healthy flap of deltoid, the latter having to be cut very short owing to the infiltration of the axilla. The dressings became offensive, but the stump healed well.

vii. For removal of the upper extremity when painful, œdematous, and heavy owing to pressure on the axillary veins and brachial plexus by recurrent carcinoma. Here removal of the upper extremity by M. Paul Berger's method (p. 221) is to be preferred. For the advisability of such operations see "Removal of the Breast."

viii. Amputation at the shoulder-joint may be called for in the following cases of aneurysm:—

A. In some cases of *subclavian aneurysm* where other means have failed or are impracticable; where the aneurysm is rapidly increasing; where the pain is constant and agonising; and where the limb is threatening to become gangrenous. While the principle of this operation appears to be physiologically sound—*i.e.*, to enable distal ligature to be performed on the face of the stump, and that, by removal of the limb, the amount of blood passing through the aneurysm may be diminished—the results hitherto have not been very successful.

Thus, in Prof. Spence's case (*Med.-Chir. Trans.*, vol. lii. p. 306), a man, aged 33, with a subclavian aneurysm, probably encroaching on the second, if not the first, part of the artery, with excruciating pain and threatening gangrene, amputation at the shoulder-joint was followed by diminution in the pulsation and size of the sac, but with little formation of coagula. Death took place four years afterwards, probably from extension of the aneurysm to the innominate and aorta. In this case the operation, though of little effect in consolidating the sac, undoubtedly prolonged life, as gangrenous, and the second part of the artery was almost certainly affected, thus a most unfavourable one. In Mr. Holden's (*St. Barthol. J.*) patient was almost *in extremis*, and the sac gave way.

Mr. Heath, *loc. infra cit.*) an intra-thoracic portion of the aneurysm also ruptured, there being no evidence as to benefit or otherwise.

In Mr. Heath's* case (the aneurysm being perhaps traumatic in origin, and of the false circumscribed kind) the effect on the aneurysm was so transient as to be practically *nil*. Two months after the amputation, as the aneurysm continued to increase in size, Mr. Heath introduced into the sac three pairs of fine sewing-needles, making each pair cross within the sac. Considerable clotting took place around the needles, which were withdrawn on the fifth day. The aneurysm gradually became solid, but the patient sank soon after from bronchitis. Mr. Heath concluded that amputation at the shoulder-joint for aneurysm is not a satisfactory proceeding, but the majority of the surgeons present were in favour of further trials of this mode of treatment if it could be resorted to early.

B. With the same objects in view, amputation at the shoulder-joint may be required in *some cases of axillary aneurysm* complicated with extension of the sac upwards, much elevation of the shoulder, conditions which may render compression or ligature of the subclavian impossible, removal of the limb being additionally called for if agonising pain or threatening gangrene be present.

Prof. Syme (*Med.-Chir. Trans.*, vol. xliii, p. 139) briefly alludes to two such successful cases, in one of which gangrene was threatening: "In a case of axillary aneurysm in a gentleman of about 52 years of age, where ligature was prevented by intense inflammation of the arm, rapidly running on to gangrene, I performed amputation at the shoulder-joint, cutting through the sloughy sides of the aneurysm and tying the artery where it lay within the sac."

C. In *some cases of inflamed axillary aneurysm* threatening suppuration, Sir J. E. Erichsen (*Surg.*, vol. ii, p. 217) pointed out that the question of this amputation may arise. As the old operation of opening the sac, turning out the clots, and securing the vessel above and below is impossible, owing to the fact that the coats of the vessel, now softened, will not hold a ligature, two courses only are open to the surgeon—viz., ligature of the third part of the subclavian, or amputation at the shoulder-joint. While the former may be followed when the aneurysm is moderate in size and when there is no evidence of threatening gangrene, amputation must be resorted to when less favourable conditions are present.

If hæmorrhage occur from an inflamed axillary aneurysm which has ruptured after the subclavian has been already tied, the same writer, of the two courses now open—viz., either to open the sac and try and include the bleeding spot between two ligatures, or to amputate at the shoulder-joint—strongly advises the latter.

The coats of the artery "in the immediate vicinity of the sac could not, in accordance with what we know to be almost universally the case in spontaneous aneurysms of large size or old standing, be expected to be in anything like a sound, firm state, and would almost certainly give way under pressure of the noose;† or the vessel might have undergone fusiform dilatation, as is common in this situation, before giving rise to the circumscribed false aneurysm, in which case it would be impossible to surround it by a ligature; or, again, the subscapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these the danger of the patient would be considerably increased by the irritation and inflammation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurysm, and much valuable time would be lost in what must be a fruitless operation, at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus to remove the whole disease at once."

D. In the words of Sir J. E. Erichsen (*loc. supra cit.*, p. 218), "there is another form of

* *Medico-Chirurgical Society (Trans.*, vol. lxiii, p. 65).

† *Ido.*, vol. i, p. 169; *Brit. Med. Journ.*, 1880, vol. i.

ler tape-like ligatures, requires that this

axillary aneurysm that requires immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not ; it is the case of *diffuse aneurysm of the armpit*, with threatened or actual gangrene of the limb."

Different Methods.—Of some thirty-six different methods which have been described, most will be found to differ in some unimportant detail. Five alone will be given here ; they will be found amply sufficient, if modified when needful, for all cases ; and of these five, Spence's, for the reasons given below, is the best, and the one with which all operators should be familiar. The circumstances under which this amputation is performed do not admit of any one definite method being followed. Thus, after a railway-accident or gunshot-injury, the soft parts will be destroyed on at least one surface. In amputating for malignant disease, skin flaps must be made use of, transfixion being usually inadmissible, as the muscles should be cut as short and as close as possible to their upper attachments, to minimise the risk of extension and recurrence. Instead of remembering the length and size of differently named flaps, the surgeon will have to be familiar with the anatomy of the parts, the position of the vessels, and the best means of meeting hæmorrhage.

The joint is so well covered that sufficient flaps* can nearly always be provided, while the blood-supply is so abundant that sloughing very rarely occurs, and even if it do so, from the results of injury or hospital-gangrene, the tissues of the chest will come forward sufficiently to close the wound. While the cavity of the axilla favours exit of discharges below, the abundance of cellular tissue opened up favours diffuse inflammation, and calls for adequate drainage.†

The following methods will be described here : in the first two, skin flaps are made ; in the others (save in the Furneaux Jordan method), transfixion is made use of, in part at least.

In all cases of doubt, as after injury, the condition of the bone, and, if needful, that of the vessels and nerves, should be first cleared up by a free incision as if for excision (Figs. 89 and 90, p. 185).

- | | |
|-------------------------------------|----------------------------------|
| i. By lateral skin flaps. The | iv. Superior or deltoid flap. |
| oval or <i>en raquette</i> methods. | v. Anterior and posterior flaps. |
| ii. Spence's method. | vi. Furneaux Jordan method. |
| iii. Superior and inferior flaps. | |

While the most rapid methods are those of superior and inferior (Figs. 95 and 96), or anterior and posterior flaps (Fig. 97), in each case cut by transfixion, these require the presence of an assistant who can be thoroughly relied upon to seize the artery just before it is cut. Where there is time, and where the soft parts admit of it, one of the methods with a vertical incision—*e.g.*, Spence's method, the *en raquette*, or that by lateral skin flaps—is far preferable, as (1) it allows of securing the artery before this is cut, thus dispensing with the preliminary

* In some cases of gunshot-injury it is necessary to get the region, and to bring this up and unite it to the cut margin of

† Finally the tendency of the skin to retract when this is over a large growth, should be remembered

pressure on the subclavian, in many cases a difficult procedure, or the seizing of the artery in the flap; (2) of exploring the condition of the head of the bone; (3) one flap can be cut longer, according to the state of the soft parts.

Means of Arresting Hæmorrhage in Amputation at the Shoulder-joint.—These are numerous. The first is, by far, the best.

1. **LIGATURING OR TWISTING THE VESSELS ON THE INNER ASPECT OF THE LIMB BEFORE THEY ARE CUT** (pp. 183, 188, Figs. 88, 91).

This method is an excellent one and suitable to all cases. The ligature should be placed as high as possible, so as to get above the circumflex arteries. The surgeon must be careful in the final use of the knife, high up in the axilla, not to prick the artery above his ligature.

2. **COMPRESSION OF THE INFERIOR OR ANTERIOR FLAP, AND SO OF THE VESSELS BEFORE THEY ARE CUT** (pp. 189, 191, Figs. 95, 96).

3. **PRESSURE ON THE SUBCLAVIAN.**—I am of opinion that the more the surgeon trusts to this plan solely, the more often will he have cause to regret it. Pressure is always liable to be inefficient in short, fat necks; in thin patients, however well applied at first with the thumb aided by a padded key or weight, it is too often rendered uncertain by the necessary changes in position of the limb during the operation, or by the pressure of assistants, a violent gush of blood at the last showing to the surgeon that his confidence in the artery being secured is misplaced. Furthermore, an assistant so used is necessarily much in the way of the others aiding the surgeon. For the above reasons I much prefer trusting to one or other of the two methods first given.

4. **LIGATURE OF THE SUBCLAVIAN ARTERY.**—Mr. Howard Marsh successfully made use of this method in a case of amputation for an enormous "osteosarcoma" of the humerus.

After ligature of the third part of the subclavian, it was easy to empty back into the general circulation the blood out of the enormous veins which ran over the surface of the growth. Eight ounces of blood was the amount estimated to have been lost.

5. **LIGATURE OF THE FIRST PART OF THE AXILLARY ARTERY.**—This step, originally recommended by Delpech, has been recently advocated by Prof. Keen (*Amer. Journ. Med. Sci.*, June, 1894) in those cases where a growth has invaded the axilla high up. Thus, a free incision between the pectoralis major and deltoid (p. 173) will at once give us access to the apex of the axilla, where the vessels lie, and enable us to determine how far the growth has extended.

6. **WYETH'S METHOD BY PINS AND ELASTIC TUBING.**—I mention this method here out of respect to the inventor and the American surgeons who have used it. I do not recommend it, for these reasons: It is clear from a paper by Prof. Keen, of Philadelphia (*Amer. Journ. Med. Sci.*, 1894), that unless the pins are inserted very exactly—not an easy matter in operations of emergency—the tubing may slip, even when applied by this method. I consider the practice of finding the vessels and tying them before they are severed a great deal simpler and more reliable in all cases. Finally, I cannot but think that, when a number of cases have been published in which the pins have been used, it will be found that the passage of long pins, and the use of elastic tubing, are always "absolutely of no importance."

Prof. Keen thus describes the method, which he used^{*} successfully in two cases, and which he thinks superior to every other:

Two sharp-pointed pins, 11 inches long and of No. 20 French catheter size, are used. As much force is required to push the pins through the tissues, it is advised that the points should be made trocar-like. The anterior pin is introduced through the middle of the anterior axillary fold, at a point a little nearer to the body than what may be called the centre of the fold transversely. The point of emergence is of much greater importance, and should be an inch within the tip of the acromion. The second pin is inserted at a corresponding point through the posterior axillary fold, emerging again an inch within the tip of the acromion. Some care is needed to avoid striking the spine of the scapula.

FIG. 86.



The pins being in position, a piece of black india-rubber tubing, half an inch in diameter, is bound tightly round the axilla and shoulder above the pins.

The method will be found described and illustrated under the section dealing with "Amputation at the Hip-joint."

7. SECURING THE VESSELS LOWER DOWN, IN THE FURNEAUX JORDAN METHOD (p. 191).

8. USE OF AN INDIA-RUBBER BAND.—This is applied after the same method as that fully given in "Amputation at the Hip-joint." In my opinion it is unreliable, especially in those cases of accident in which, the limb being mutilated high up, this operation is chiefly

required. For in these the band, being applied under the axilla and across the body, slips up as soon as the head is disarticulated, allowing of bleeding from the vessels, and coming, itself, most inconveniently, and a possible source of infection, into the way of the operator.

i. **Lateral Flaps—Oval—En Raquette** (Figs. 86 to 92).—The method of lateral flaps, or the above modifications of it, or Spence's method, are those which the student is especially recommended to practise, on account of the advantages already given.

The methods of arresting the hæmorrhage are given above. The patient having been propped up sufficiently, brought to the edge of the table, and rolled over to the opposite side, the surgeon,* standing outside the abducted limb on the right side, and inside it on the left, and having marked with his left forefinger and thumb a point just below and outside the coracoid process, and a corresponding point behind in the mid-axilla (Fig. 86), then reaches over, and, entering the knife in the axilla, close to the thumb, cuts an oval flap, about 4 inches long, consisting of skin and fascia from the side farthest from him, and ending close to his finger. Without removing the knife, the surgeon next marks out a similar flap on the other side, cutting from

* Three assistants are required—No. 1, to manipulate the limb; No. 2, to grasp the artery in the inner or inferior flap, if desired; No. 3, to be ready with sterilised pads or instruments. If the subclavian is to be controlled, this must be done by a fourth. If short-handed, the surgeon will manipulate the limb himself.

above downwards, commencing just below the finger, and ending where the first flap began in the mid-axilla. The assistant in charge of the limb aids the above by rotating the limb into convenient positions. The flaps are then dissected up and held out of the way. The vessels are next exposed (see p. 185), separated from the surrounding nerves, and secured, either by applying two pairs of Spencer Wells's forceps (Fig. 88), dividing the vessel between them and twisting both ends, or by passing an aneurysm-needle, loaded with sterilised silk, under the artery, and thus securing it with two ligatures. The limb being then

FIG. 87.



Disarticulation at the shoulder-joint, the humerus being fractured high up. The operator with his left hand twists the humerus outwards, while, with his right, he divides the capsule and insertion of the subscapularis. (Farabeuf.)

carried across the chest, the outer part of the capsule is freely opened by cutting on the head of the bone, and the muscles attached to the great tuberosity thoroughly severed. The limb is next rotated outwards, and the subscapularis tendon severed; the biceps tendon being cut and the capsule freely opened, the joint is well opened on the inner side. The head being then dislocated,* by the assistant pressing the elbow forwards and against the side, the knife is passed from the outer

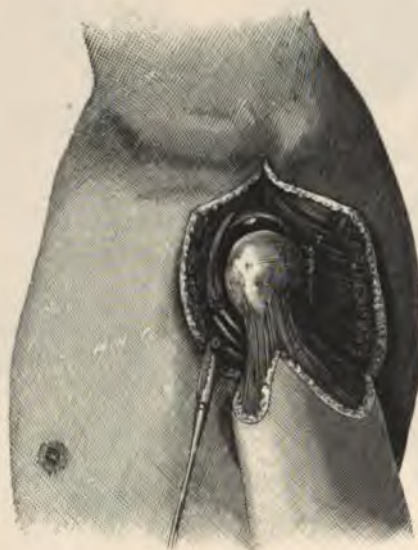
* This will only be feasible if the capsule has been deliberately and thoroughly opened. In any case where the leverage of the humerus is wanting, owing to this bone being broken higher up, the use of lion-forceps (Fig. 87) will be necessary for disarticulation; or the surgeon will follow the expedient of Prof. Syme, *op. cit.*, *et. of Surg.*, vol. iii. p. 100, who inserts his finger into a wound made in the skin, and draws it out as to gain the purpose of

side behind the dislocated head, and, being kept close to the inner side of the bone, is brought out through the structures on the inner aspect of the arm, care being taken, as the knife cuts its way out, that it does so below the point where the large vessels have been secured.

In this or any other amputation here for tuberculous or malignant disease, it will be needful to scrutinise carefully the condition of the parts left, to dissect out any glands, whether enlarged or not, together with the synovial membrane, and in some cases, to remove the glenoid cavity with bone-forceps, or preferably, a fine sharp saw, or chisel.

Method en Raquette with Preliminary Exploration (Farabeuf) (Figs. 89 to 92).—The point of the knife having been sunk just below

FIG. 88.



Amputation at the shoulder-joint by lateral flaps. These are turned aside, while the axillary artery is secured by torsion before disarticulation is completed.

and in front of the tip of the acromion, an incision is made downwards, sufficiently long and deep to admit of exposing the head of the humerus. If amputation is decided on, the above is converted into one *en raquette* by making an oblique incision which passes from about the centre of the longitudinal one (Figs. 89 and 90) across the inner or the outer aspect of the limb (according as it is right or left), and ends behind on a level with the lower extremity of the longitudinal one. A second exactly symmetrical to the first is next made over the opposite aspect of the limb, beginning where the first ended, and terminating in the longitudinal incision opposite to the first (Fig. 90). The next step is the exposure of the artery by division of the muscles. In the curved inner incision (Fig. 90) are seen the anterior fibres of the deltoid almost blended with the insertion of the great pectoral. This is raised with the finger, and the insertion of the great pectoral detached from

the bone. If now the inner flap be folded inwards, the coraco-bicipital fasciculus comes into view. The aponeurosis over it being opened by a free longitudinal incision, the muscular fasciculus is drawn over the front of the humerus and cut across. If an assistant now thoroughly retract the inner flap, the axillary vessels and nerves are exposed. The artery should be isolated and tied as high up as possible, so as to get above the posterior circumflex. The knife being again inserted into the outer oblique incision, the deltoid is boldly cut through as far as the back of the axilla. An assistant next retracts the outer and inner flaps, while the surgeon opens the capsule freely, the limb being rotated as directed (p. 183). The head is next thrown out of the

FIG. 89.



FIG. 90.



Amputation at the right shoulder-joint by the method *en raquette*. The knife is tracing the flaps, after a free exploratory incision has been made. (Farabeuf.)

socket, and the knife is carried behind the head, skirting the postero-internal aspect of the humerus very closely, so as not to cut the secured artery, and finally brought out through the incision on the inner side, severing the latissimus dorsi and teres major. If the artery has not been tied, an assistant secures it between his thumb, sunk deeply into the wound, and his fingers, which are in the axilla, or by using both hands.

ii. **Spence's Method** (Fig. 94).—This excellent modification of the oval method is one with which the young hospital-surgeon should be familiar owing to the facility with which the vessels can be secured and hæmorrhage met—a point of much importance in cases of accident, and when, as at night-time, the operator may be short-handed. For this reason I consider it first in value. It is further especially suited to cases of failed excision,* or to cases of injury—*e.g.*, gunshot—where

* At the present day, in cases of failed excision, the surgeon will often prefer to make use of the modification of the Furneaux Jordan method (p. 191).

the surgeon has to cut into and explore the condition of the joint before deciding on excision or amputation. By its means an excision can readily be converted into a disarticulation, if this step be found needful. It has other advantages, but less important ones:

1. The posterior circumflex artery is not divided, except in its small terminal branches in front, whereas, both in the large deltoid flap and the double flap methods, the trunk of the vessel is divided in the early steps of the operation, and, retracting, often gives rise to embarrassing hæmorrhage.
2. The great ease with which disarticulation can be accomplished.
3. The better shape of the stump. Prof. Spence

FIG. 91.



The anterior fibres of the deltoid, the insertion of the pectoralis major, and the coraco-brachialis and biceps have been cut. The left hand of the operator draws the large nerves downwards, and thus exposes the axillary artery for ligature. (Farabeuf.)

pointed out that, however excellent are the results soon after other methods, later on, the shape of the stump is much altered, not merely from the atrophy common to all stumps, but from retraction of the muscular elements of the flaps, the pectoralis major retracting towards the sternum, and the latissimus dorsi and teres major towards the spine and scapula. Thus a deep, ugly hollow results under the acromion.

Fig. 93 shows an instance of this, in a case of amputation of both upper limbs in a young subject. E. D., aged 10, was admitted under my care in Guy's Hospital for a terrible crush of both upper extremities, from his having been run over by a timber-waggon. I amputated at once through the left shoulder-joint by superior and inferior flaps. An attempt was made to save the right limb, but owing to gangrene setting in, amputation became necessary, and was performed high up through the humerus. Mr. G. A. Wright, of Manchester, then House-Surgeon. The resulting projection

left acromion from wasting of the muscles was well shown when, nine years later, he again came under my care for a conical and tender stump on the right side, due here to the unbalanced growth of the upper epiphysis. The writing below the figure was done by the lad with his teeth.

The operation is thus described in Prof. Spence's words (*Lancet*, 1867, vol. i. p. 143; and *Lect. on Surg.*, vol. ii. p. 662): "Supposing the right arm to be the subject of amputation. The arm being slightly abducted, and the head of the humerus rotated outwards if possible, with a broad strong bistoury I begin by cutting down upon the head of the humerus, immediately external to the coracoid process, and carry the incision down, through the clavicular fibres of the deltoid and pectoralis major, till I reach the humeral attachment of the latter muscle, which I divide. I then, with a gentle curve, carry the incision

FIG. 92.



Parts composing the flaps made by the *en raquette* method. (Farabeuf.)

FIG. 93.



Edward
Davies.

across and fairly through the lower fibres of the deltoid towards the posterior border of the axilla, unless the textures be much torn. I next mark out the line of the lower part of the inner section by carrying an incision *through the skin and fat only*, from the point where my straight incision terminated, across the inside of the arm, to meet the incision at the outer part. This ensures accuracy in the line of union, but is not essential. If the fibres of the deltoid have been thoroughly divided in the line of incision, the flap so marked out can be easily separated (by the point of the finger, without further use of the knife) from the bone and joint, together with the trunk of the posterior circumflex, which enters its deep surface, and drawn upwards and back to expose the head and tuberosities. The tendinous the long head of the biceps, and the directly on the tuberosities and tendon especially, being very easily and completely

divided than in the double flap method. By keeping the large outer flap out of the way by a broad copper spatula or the finger of an assistant, and taking care to keep the edge of the knife close to the bone, as in excision, the trunk of the posterior circumflex is protected. Disarticulation is then accomplished, and the limb removed by dividing the remaining soft parts on the axillary aspect. The only vessel which bleeds is the anterior circumflex, divided in the first incision, and here, if necessary, a pair of catch-forceps can be placed on it at once. In regard to the axillary vessels, they can either be compressed by an assistant before completing the division of the soft parts on the axillary aspect, or, as I often do in cases where it is wished to avoid all risk, by a few touches of the bistoury the vessel can be exposed, and can then

FIG. 94.



Amputation at the shoulder-joint by
Spence's method. (Stimson.)

FIG. 95.



be tied and divided between the two ligatures, so as to allow it to retract before dividing the other textures.”*

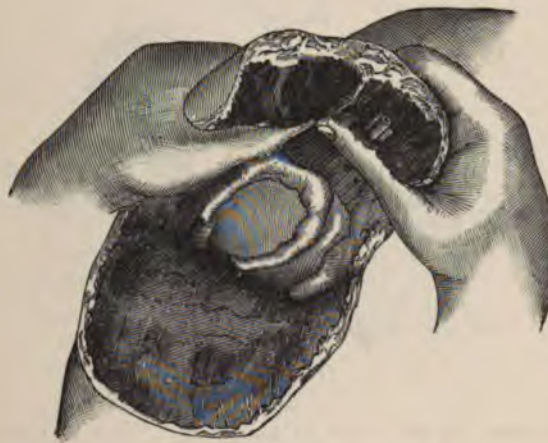
iii. **Amputation by Superior and Inferior Flaps.** (Figs. 95 and 96).—The patient having been brought to the edge of the table, turned sufficiently over, and his shoulders supported by pillows, the assistants are arranged as before (footnote, p. 182). The arm being a little raised so as to relax the deltoid, the surgeon, standing inside the limb on the right side and outside it on the left, lifts the deltoid muscle with his left hand, and sends the knife (narrow, strong, and no longer than needful) across beneath the muscle, entering it on the right side, just below the coracoid process, and bringing it out a little below the most prominent part of the acromion,† or *vice versâ*, according to the side operated upon. The knife should pass close to the anatomical

* Where the limb is very muscular, Prof. Spence recommended to raise the skin and fat from the deltoid at the lower part, and then to divide the muscular fibres higher up by a second incision, so as to avoid excess of muscular tissue.

† Unless care is taken to keep thus below the acromion process, there will be some tendency for this bone to protrude in the wound.

neck of the humerus, without hitching upon it, and the flap should be cut broadly rounded, and well down to the insertion of the deltoid. It is then raised and retracted, and, the capsule being now exposed, the joint is opened by cutting strongly upon the head of the bone. The arm being now rotated outwards vigorously by an assistant or by the surgeon, the subscapularis, thus made tense, and the biceps are brought into view and severed; the limb is next rotated inwards, being carried across the chest, and the muscles attached to the great tuberosity are divided. The capsule is next still more freely opened, and the head of the bone, now freed, is pushed up by the assistant and pulled outwards from the glenoid cavity. The knife is next slipped behind the head (Fig. 95), and cuts its way along the under aspect of the neck and shaft of the humerus, so as to shape an inferior flap half the length of

FIG. 96.



To show the manner in which bleeding is controlled in the inferior flap: the axillary vessels are compressed by one thumb, the posterior circumflex by the other.

the upper one.* As soon as the knife is passed behind the bone, an assistant slips his hands in behind the back of the knife (Fig. 95), following it so as to grasp firmly the soft parts in the inferior flap, and thus control the axillary vessels (Fig. 96).

The large vessels are next secured, then the circumflex, and muscular branches that require it; any large nerves that need trimming are then cut short, drainage, if necessary, provided, and the flaps brought into position.

This amputation has the advantage of being very quickly done, and of giving a flap which keeps in position by its own weight, and thus gives good drainage. If the soft parts below the humerus are much damaged, the upper flap must be cut proportionately long.

* The surgeon should not cut this till he is told that the flap is held firmly; and, in cutting it, he must be careful of his assistant's fingers.

iv. **Amputation by Deltoid or Upper Flap.**—This is merely a modification of the last. The deltoid or upper flap may be cut by transfixion, or made by cutting from without inwards. In either case it must be of very full size, and thus is useful when the axilla is damaged, but it has the disadvantage of leaving next to no flap in which an assistant can seize the axillary vessels; and, owing to the powerful retraction of the muscles in the axillary folds, unless the upper flap is cut full in length and size it will not cover the resulting wound. Finally, as the trunk of the posterior circumflex is cut, sloughing of the large deltoid flap may take place, especially if the tissues composing it are at all damaged previous to the amputation. Owing to these disadvantages, which outweigh its rapidity, this method is not to be recommended, a short under-flap being always cut if possible. When the surgeon, having disarticulated, is cutting straight down, unable to make any flap below, assistant No. 2 (footnote, p. 182)

FIG. 97.



(Fergusson.)

should try to draw up the skin of the axilla, while assistant No. 1, in charge of the limb, should be careful not to draw down the skin, otherwise, owing to the laxity of the skin in the axilla, any downward traction will bring the skin of the thoracic wall under the knife.

v. **Amputation by Anterior and Posterior Flaps** (Fig. 97).—This is indicated when the soft parts on the front and inner aspects are damaged. The position of the patient being as advised at p. 188, and the limb being carried somewhat upwards, backwards, and outwards, the surgeon, standing, if on the left side, behind and outside the shoulder, enters his knife just in front of the posterior fold of the axilla, thrusts it across the back of the humerus as near the head as possible, so as to get in front of the tendons of the teres major and latissimus dorsi, and bringing it out close to the acromion, cuts, with a sawing movement, a flap 4 to 5 inches long,* which is next well retracted by an assistant. The arm being then carried across the chest, the joint is freely opened behind, the muscles attached to the tuberosities severed, the knife passed between the head and the glenoid cavity (to facilitate this, the limb should now be carried over the chest, and

* In the posterior flap will be the posterior part of the deltoid, the latissimus dorsi, and teres major.

the head of the bone pushed backwards), then between the bone and the pectoralis major, and an anterior flap,* 4 inches long, cut from within outwards. Hæmorrhage from the large vessels is arrested either by an assistant grasping this flap as it is cut, much as at p. 189, Fig. 95, or by the surgeon isolating the axillary vessels (the biceps and coraco-brachialis will guide him) and securing them by torsion or ligature (p. 185) before he completes the operation by cutting the anterior flap. When operating on the right limb, the patient being turned well over on to his left side, the surgeon, standing here inside the arm, which is held upwards and backwards so as to relax the deltoid, lifts this muscle up with his left hand, and then passes his knife from just below the acromion, transfixing the base of the deltoid, grazing the back of the humerus, and finally thrusts the point downwards and backwards through the skin till it comes out at the posterior margin of the axilla. This flap, 4 or 5 inches long, should be dissected up, the joint opened behind, and the operation completed as before.

vi. **Furneaux Jordan Method.**†—This may be made use of both as a primary and a secondary amputation. The following are suitable cases:

a. Certain cases of injury.—Where, though the parts about the shoulder-joints are intact, the humerus is badly split up into the joint. The soft parts are divided down to the bone by the circular method, 3 to 4 inches below the axilla, the main vessels secured, and the humerus then shelled out by a longitudinal incision along the outer and posterior aspect of the limb, meeting the circular one at a right angle.

b. In cases of failed excision.—Here, after amputation of the limb by the circular method, the rest of the bone is turned out through the excision wound prolonged into the circular one.

c. After amputation in the middle of the arm in some cases.—*E.g.*, when the stump is the seat of osteo-myelitis, necrosis, or otherwise does not do well.

EXCISION OF THE SHOULDER-JOINT (Figs. 98 to 103).

This operation is but rarely performed—(1) owing to the comparative infrequency of diseases of the above joint, especially of tubercular disease, which require operative measures; (2) from the fact that epiphysitis and infective synovitis usually give, after free incision and drainage, as good a result as can be obtained after excision. This is mainly owing to the fact that much of the stiffness that otherwise would be present is made up for by the supplementary mobility of the scapula, especially in young subjects.‡

The above remarks naturally lead up to the consideration of the

* In this anterior flap will be the remaining fibres of the deltoid, the pectoralis major, and the large vessels and nerves.

† For the details of this method see "Amputation at the Hip-joint."

‡ In future, by the use of a simple longitudinal incision with a minimum of interference with the deltoid, aided by antiseptic precautions from the first, and with earlier and persevering adoption of passive movements, the above statement may have to be modified. The excellent results claimed by Prof. Kocher for his posterior incision are alluded to at p. 203.

amount of movement which is gained after the operation of excision. The arm cannot usually be abducted and elevated beyond the horizontal line; too often it lies close to the chest. Even if the deltoid retained its power of elevation, it could not often exert it, as in most operations, owing to the amount of bone removed, the fulcrum of the head of the humerus against the glenoid cavity has gone. Prof. Longmore (*Resection of the Shoulder-joint in Military Surgery*, p. 12) writes:—"The loss of the elevating action of the deltoid must be accepted, like the loss of the rotating power from the division of the muscular insertions into the two tubercles, as a necessary consequence of resection of the head of the humerus. But the holding or supporting power of this muscle exerted upon the whole upper extremity owing to its position, its extensive origin, and the manner in which it embraces and protects the mutilated parts, as well as its faculty of assisting in carrying the arm backwards and forwards, are all functions which may still remain, and serve to point to the great importance of preserving its integrity as fully as possible. The wasting of the internal fibres (footnote, p. 201), however, seems a necessary result of resection by the single incision, but it has this compensating feature, that it is a less serious loss to the patient than an atrophied condition of the outer and posterior fibres would be, because the upper clavicular fibres of the great pectoral can take the place of the inner deltoid fibres to a considerable extent in supporting the shoulder and drawing it forwards to the chest."

Sir J. E. Erichsen (*Surgery*, vol. ii. p. 251) spoke thus of the four chief movements of the shoulder-joint—viz., "(1) abduction and elevation, (2) adduction, (3) and (4) movements in the antero-posterior direction—these are requisite in all ordinary trades for the guidance of the hand in most of the common occupations of life. The movements of elevation are seldom required save by those who follow climbing occupations, as sailors, masons, &c. Now, the mode of performing the operation, as well as the operation itself, will materially influence these different movements. Thus, if the deltoid be cut completely across, the power of abduction of the arm and of its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision, they may be regained in great part. All those movements of rotation, &c., which are dependent on the action of the muscles that are inserted into the tubercles of the humerus will be permanently lost; for, in all cases of caries of the head of the humerus requiring excision, the surgeon will find it necessary to saw through the bone below the tuberosities—in its surgical, and not its anatomical, neck.* Hence the connections of the supra-spinatus and infra-spinatus, the teres minor, and subscapularis will all be separated, and their action on the bone afterwards lost. But those muscles which adduct, and which give the antero-posterior movements—viz., the coraco-brachialis, the biceps, the pectoralis major, latissimus dorsi, and teres major—will all be preserved in their integrity; and hence it is that the arm, after this excision, is capable of guiding the hand in so great a variety of useful under-handed movements."

* With all proper deference to the opinion of Sir J. E. Erichsen, this opinion appears to be too definite and inelastic. I would refer the reader to the remarks below on the site of section of the bone, and on subperiosteal resection (pp. 204, 208).

Indications.

i. Different forms of arthritis disorganising the joint, resisting careful treatment, in subjects whose age, general condition, &c., are satisfactory—viz.:

(a) Tubercular disease, resisting other treatment and going on to caries. As in all excisions the stage of advanced caseation, sinuses, and mixed infection should be ante-dated. Another reason for early excision here is given by Messrs. Watson Cheyne, C.B., and Burghard (*Man. of Surg. Treat.*, pt. iv. p. 252): "Shoulder-joint disease is very frequently associated with or followed by disease of the lungs; the exact connection of the two is difficult to understand, but it is certainly a clinical fact that a large number of patients suffering from this affection suffer also from phthisis, and, in a very considerable proportion, the latter affection only occurs after the joint disease has lasted for some time." (β) Disorganisation of the joint after rheumatic fever, gonorrhœal arthritis, wrenches, &c., resulting in crippling ankylosis, in a young subject. (γ) Osteitis going on to suppuration, caries, &c. (δ) Epiphysitis, suppurating or acute necrosis, where the discharge, necrosis, suppurating arthritis, &c., are exhausting the patient, and the outlook as to natural cure is not good. (ε) Disease of the deltoid bursa, ulcerating into the joint and setting up destructive arthritis.

ii. Gunshot injuries, where the large vessels and nerves have escaped, where fragments of shell, bullets, &c., are lodged in the head of the bone, especially if the shaft of the bone is not much damaged (p. 211).

iii. Compound dislocation and compound fracture with much damage to the capsule and cartilage of the head of the bone, the large vessels and nerves being intact.

iv. Some cases of ankylosis—*e.g.*, after acute rheumatism or traumatic arthritis and suppuration. Here the question of operative interference will mainly turn on how far the additional movements of the scapula and humerus together have made up for the ankylosis, and the degree of atrophy of the muscles.

Dr. E. Souchon, of New Orleans, to whose masterly article on operative interference in Irreducible Dislocations of the Shoulder-joint I refer at p. 195, has dealt with the treatment of ankylosis of this joint as helpfully in another article (*Trans. Amer. Surg. Assoc.*, 1896, p. 409). He considers that operation is only justifiable in recent cases in full-grown subjects or in patients of sufficient age to ensure that the removal of the head of the humerus will not be followed by too great shortening. It is especially indicated in ankylosis following arthritis with a rapid course (dry, acute arthritis) observed sometimes in subjects affected with acute rheumatism, and especially blennorrhagic arthritis; also in cases consecutive to suppurating traumatic arthritis. In these cases the ankylosis occurs before the atrophy of the muscles. The cases of ankylosis which should not be operated on are—(1) those with a fairly useful limb as it stands, unless there is positive assurance of improving the movements, especially those that are particularly needed for the patient's work; (2) where atrophy of the muscles is present. The application of electricity and massage may be required for some time before it is decided that the operation will be useless. Operation is contraindicated especially when the muscles are

irretrievably degenerated, as is the case in a great number of old ankyloses, and particularly those following long articular suppuration.

v. Some cases of unreduced dislocation of the head of the humerus. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 738) wrote long ago :—"I have often thought that, in cases of irreducible dislocation attended with much pain, the removal of the head of the bone might be justifiable, but have not met with any case in which the operation has been performed."* Lord Lister (*Edin. Med. Journ.*, March, 1873) excised the head of the humerus after securing a rupture of the axillary artery,† this vessel having given way in an attempt to reduce a dislocation of eight weeks' standing. The patient, aged 58, sank three hours later. Considering the frequency with which this accident has taken place in attempting to reduce old dislocations of the shoulder, it would be wiser, in these days of modern surgery, to attempt to improve the condition of things by excising the displaced head. Mr. Sheild brought before the Medico-Chirurgical Society (*Trans.*, vol. lxxi., 1888, p. 173) a man, aged 45, on whom he had performed excision for a neglected sub-coracoid dislocation of twelve weeks' standing.

Owing to pressure on the median and ulnar nerves, the hand was almost useless. Moderate attempts at reduction having failed, the head was removed through the anatomical neck, this site being chosen in order to disturb the parts as little as need be. The end of the bone was made as like the real head as possible by careful rounding. Twelve weeks afterwards the patient was able to resume work as a waiter. The movements of the shoulder were satisfactory, and the hand gradually regained strength.

Lord Lister published (*Brit. Med. Jour.*, 1890, vol. i. p. 1) two similar cases treated by operation, but somewhat differently.

They were both instances of bilateral sub-coracoid dislocation, due in the one case to a fall from a tree, in the other to epilepsy. The patients, aged 47 and 23, were each pitifully helpless. In three of the joints, the usual incision having been made between the deltoid and pectoralis, the subscapularis tendon was divided, and the soft parts detached from the head of the bone and the inner side of its neck. This was done to ensure the vessels being entirely set free from the head of the bone. The pulleys were next used, and, the head not returning, it was protruded out of the wound, and the insertions of the

* While this operation is one of recent date in England, credit should be given to those surgeons who have practised it, years ago, elsewhere. Cases will be found recorded by Post, of New York, in 1861; by Warren, of Baltimore, in 1869. In Germany, Langenbeck, Volkmann, Cramer, Kuster, Kronlein, and others operated for recurrent dislocation and old dislocation of the humerus. M. Léon Tripier published a successful case of resection of the head of the humerus, which, fractured as well as dislocated, was pressing on the brachial artery and threatening gangrene. A full bibliography is appended to Dr. Souchon's article, the best on this subject (*vide infra*, p. 195).

† The condition of the parts found here is most noteworthy. A broad and strong fibro-osseous band, connecting the humerus with the coracoid process, lay over the head of the bone, and at the same time was intimately connected throughout by condensed tissue with the sheath of the axillary artery, which lay over it. Thus the vessel, instead of being surrounded by loose and yielding structures, was attached by a fibro-osseous band to the coracoid process on the one hand, and the neck of the humerus on the other; and when these were separated from one another by the attempts at reduction, the artery as well as the band was subjected to violent traction. Accordingly, the band, strong as it was, was found to have been torn right across, and the rent in it was exactly opposite to the rupture in the artery. Atheroma in the vessel served to explain still further the disaster.

external rotators cut through, after which the pulleys were used successfully. In the case of the fourth joint the articular portion of the head was removed piecemeal with a chisel, without interfering with the tuberosities or the external rotators. This allowed the head to drop readily into the glenoid cavity. The result of these operations was a "grand success," but the operator thought that excision gave a result inferior to the other.

In Lord Lister's words (*loc. supra cit.*, p. 3):—

"The attachments of all the rotators to the tuberosities were divided, and yet you saw that they have completely re-formed; rotation is perfect, both external and internal. And in the other patient, though the dislocation had been of so much longer standing (seven months), the use of the previously wasted rotators had been completely restored. I would advise that when the surgeon feels in doubt as to whether it is prudent to make attempts at reduction, or when such attempts do not succeed, he should, in the first place, cut down upon the bone by the usual incision from the coracoid process downwards and a little outwards, and then, with a curved periosteum-detacher, freely separate the soft parts from the inner side of the upper end of the humerus. You will then be sure that no damage will be done to the axillary vessels in any manipulations which you may make. In many cases you will doubtless succeed by these means; but if this fails, then these instances show that you may proceed to turn out the head of the bone, detaching the insertion of the rotator muscles, and after reduction you will have a thoroughly useful limb. Should even this procedure fail, removal of the head of the bone is easily open to us, with the promise of a good though inferior result."

It is noteworthy that in the case of reduction without excision there was a remarkable tendency to the formation of adhesions, and the recovery of movement was extremely slow. In another, the maintenance of passive movement kept up a serous oozing and delayed the healing of the wound. In the only case in which the date is given at which passive movements were begun, this is stated to have been the thirteenth day. Anæsthetics were required twice, and the recovery of power was extremely slow. Massage and galvanism aided greatly in the improvement. Strict antiseptic precautions are needful throughout, as, if inflammation sets in, ankylosis is almost certain.

Mr. Pearce Gould and Mr. Watson Cheyne, C.B., showed similar cases at the Medical Society (*Lancet*, 1892, p. 474).

Reduction was in each case effected after division of the muscles. In one case the range of movement was somewhat defective, and there was a tendency for the head of the humerus to slip forward. But here four months had elapsed between the dislocation and the reduction; it was needful in this case to clear out the glenoid cavity, and the patient failed to attend subsequently.

Mr. Thorburn (*Med. Chron.*, vol. xiv. p. 8) excised the head of the humerus through the surgical neck, in a case diagnosed as subclavicular dislocation and fracture with irregular formation of callus. He points out that division of tendons would here have been insufficient, as such a deformed head, if even thus reduced, would not have fitted into the glenoid cavity.

Mr. F. C. Wallis published (*Clin. Soc. Trs.*, vol. xxxi. p. 291), a case in which an instructive condition was found at the operation. The patient had had a dislocation of the right shoulder reduced three weeks after the accident. The joint was ankylosed. The muscles of the arm were wasted and paralysed, the movements of the elbow and wrist-joints very limited and the fingers quite stiff. The limb was the seat of neuralgic pains. When the head of the humerus was excised, the cords of the brachial plexus were adherent to the inner side of the bone, and required detachment. Massage was begun early. The patient lost all her pain, regained good movements of the shoulder-joint, and could again dress and feed herself. The fingers, remaining stiff, still required her attention.

The most complete and helpful contribution on this subject is a paper by Dr. E. Souchon, of New Orleans, "Operative Treatment of Irreducible Dislocations of the Shoulder-joint, Recent or Old, Simple or Complicated" (*Trans. Amer. Surg. Assoc.*, 1897, p. 311). This is

a most elaborate and helpful study, based on 154 cases of operation, and abounds with those details which are so valuable to surgeons who may have to deal with these occasional but most difficult cases. The following are the chief conclusions of Dr. Souchon:—"The anterior incision is the route. Reduction is the more desirable operation, because it preserves the head and all the movements depending therefrom. Reduction should be done only in cases where the head and glenoid cavity are in good condition; when no extensive dissections have to be made; when it is easily effected without any great effort; when the head does not need to be trimmed, or the cup to be too deeply scooped or enlarged; when the head readily remains in place, but not too tightly. All this regardless of the time or standing of the dislocation. It should, however, always be attempted conscientiously, because many have resected, perhaps, when the dislocation could have been reduced.* Disregard of these rules may result in necrosis of the head, in recurrence of the dislocation, or in ankylosis, with their inevitable consequences. Resection should be practised in all other cases. When in doubt, it is preferable to resect. How much to resect—*i.e.*, when to saw through the anatomical neck or obliquely and downward outside the tuberosity, or horizontally on a level with the lower margin of the head—must be determined in each case; it is better to remove too much than too little. Of course, all efforts should be made to secure aseptic results. A most important point is to get primary union."

Amongst the difficulties of reduction, the following instances are given:—The capsule may be replaced by a thick fibrous mass, the head having thus lost its "right of domicile." Adhesions of the capsule to the glenoid cavity. Such complete healing of the rent in the capsule as to prevent reduction. Strong adhesions between the new cavity and the neck or head of the humerus. Such bands may be adherent to the vessels and nerves, p. 194. Sclerosis of the muscles, rendering their section necessary. Alteration in the shape of the head of the humerus. Usually several of the above causes combine to interfere with reduction or resection.

Dr. Souchon's elaborate article shows that amongst the difficulties and complications which may be expected during the operation the chief are:—A very thickened capsule or much fibrous tissue about the head of the humerus, necessitating a tedious dissection, with persistent oozing. The head may lie very deep, and be adherent to the adjacent parts, *e.g.*, the ribs, and the deeper the position the greater the risk of serious hæmorrhage. When thus firmly fixed the head may be prised into its natural position by elevators, scoops, or blunt scissors, and this failing,

* In young subjects reduction should always be preferred to resection, and if the latter is employed, the epiphysial cartilage should not be injured, if possible. At p. 349 of Dr. Souchon's paper a case (reported by I. Wolff, *Berl. klin. Woch.*, 1886, SS. 897-903) of downward dislocation is recorded, due to a severe accident. There was paralysis of the muscles, so that a finger could be pushed between the head and the acromion. A thin layer of cartilage having been chiselled off the humerus and glenoid cavity, the two were wired together. Four months later the improvement was marked. Dr. Souchon also refers to three cases of dislocation occurring in very early life, and perhaps due to injury at birth, treated by resection.

division of the bone may be needful, the head being then lifted out by the above-mentioned instruments or loosened with lion-forceps. In other cases it may be wiser to remove it piecemeal. The glenoid cavity may be so filled up as to "need refashioning.*" The packet of vessels and nerves may lie across the head of the bone. In the manipulations needful to get the head into place, the neck of the humerus may give way.

As *results of the operation*, hæmorrhage, gangrene, necrosis and a sinus, and exfoliation of cartilage have occurred. The death-rate is given as 10 per cent. in reductions and 12 per cent. in resections; and while, no doubt, this will be diminished with the advantages of modern surgery, those who study carefully the difficulties which may beset this operation, especially in long-standing cases, will always look upon it as by no means a light one.

It remains to consider very briefly the question of surgical interference in that rare combination of accidents, viz., *fracture of the*

FIG. 98.



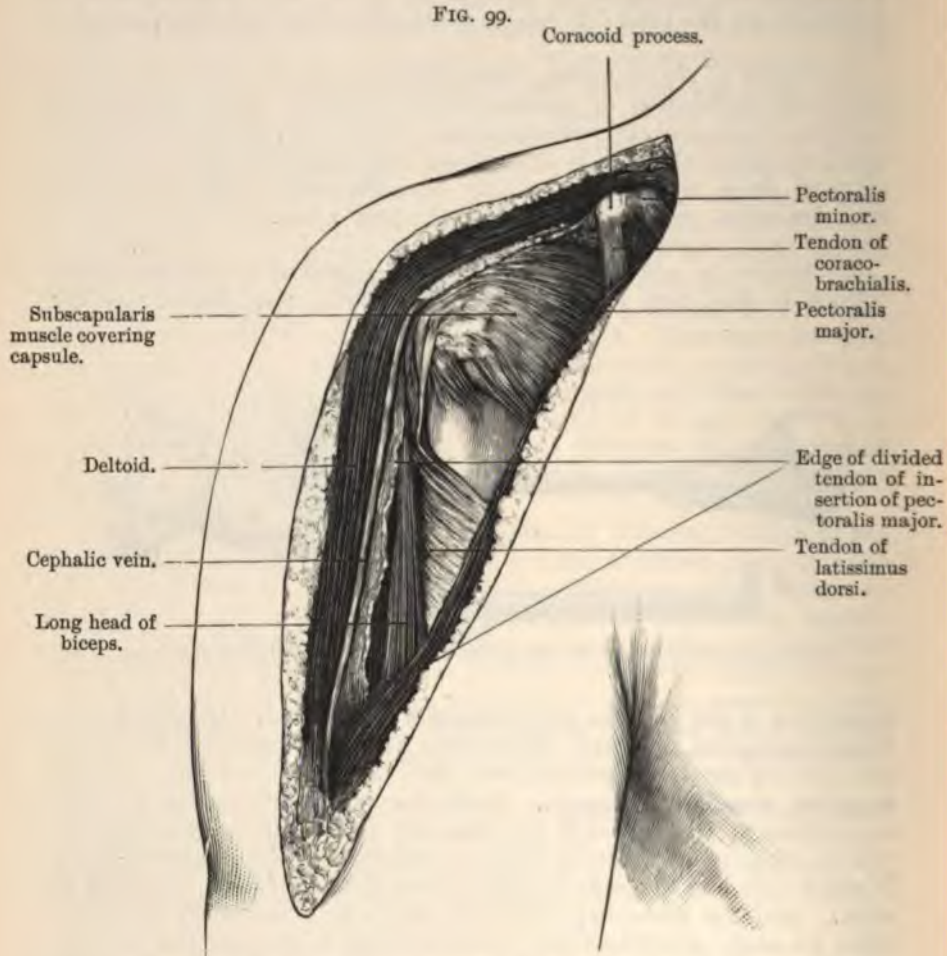
McBurney's traction-hook for the reduction of fractured and dislocated bones.

upper part of the humerus and dislocation of the head. If reduction is found impossible, operative interference will be justifiable in a healthy and actively employed patient, and when the conditions necessary for complete asepsis are present. Reduction of the dislocation by such an incision as that given at pp. 199, 201, and suture of the fracture, will be preferable in recent cases to resection of the fractured head. If union fails and the joint is useless, resection should be performed at once. And the same step should be taken as a secondary operation when all acute symptoms have subsided and it is clear that serious disability and pain are caused by the dislocated head. To meet the difficulty of bringing the upper fragment into position, Dr. C. McBurney, of New York, has made use of the traction-hook (Fig. 98) which bears his name.

The case was one of oblique fracture of the neck of the humerus, the upper fragment being dislocated under the coracoid process, and by its small size resisting all attempts at dislodgment and replacement. Dr. McBurney, two weeks after the injury, exposed the fragment, drilled it, and readily reduced it with his traction-hook. A perfect result followed (*Ann. of Surg.*, 1894, vol. i. p. 399).

If both the glenoid cavity is refashioned and the head of the humerus resected, and the two are then placed in contact, ankylosis may follow.

vi. Recurrent dislocation of the shoulder. Dr. Burrell and Dr. Lovett, of Boston, have contributed a paper on this subject, with six cases, two of which were operated upon, with an excellent result in each case (*Trans. Amer. Surg. Assoc.*, 1897, p. 293). This is



Field of operation in habitual dislocation of the shoulder. (Burrell.)

occasionally met with in patients who have not given the joint sufficient rest at first, or in those who are the subjects of epilepsy.

Amongst the pathological conditions, which vary widely, these writers consider the following to be established: (1) Laxity of the capsule; (2) Tearing away of the capsule from the glenoid cavity; (3 and 4) Partial fracture of the head of the humerus or the glenoid cavity; (5) Tearing away of muscular insertions, *e.g.*, the spinati, or rupture of the biceps tendon; (6) Altered shape of the head of the humerus, probably the result of chronic inflammation. The following are the chief steps of the operation performed by Dr. Burrell in the two cases referred to above. Where a trial of primary fixation for a few weeks, combined with massage of the muscles, followed by careful movements of the

joint, fails after ten weeks, partial resection and suture of the capsule* is recommended, unless any abnormalities be found which require removal of the head of the humerus. A free incision having been made in the pectoro-deltoid interval, the cephalic vein drawn aside, the coraco-brachialis and biceps are recognised in the upper and the pectoralis major in the lower part of the wound. Division of the upper three-quarters of the insertion of the latter muscle is recommended so as to expose thoroughly the head and neck of the bone. The long tendon of the biceps will be seen and felt through its sheath. The incision should be carried in its whole depth up to the coracoid process, and the tendons of the biceps and coraco-brachialis cleared up to this point. By rotating the head outwards and dropping it backwards, the insertion of the subscapularis is stretched over the head of the bone. A portion of this insertion should be divided. The arm is next abducted, raised to a horizontal position, and the head of the bone pressed backwards so as to prevent its coming up under the coracoid process, which it tends to do in these cases,† and also to relax the front of the capsule. If the joint appear normal the loose part of this ligament is then grasped with vulsellum forceps, and a fold three-quarters of an inch in length and three-eighths of an inch wide excised. The gap is then sutured, rendering the capsule distinctly tighter and shorter.

Mr. Southam (*Brit. Med. Journ.*, vol. ii. 1892, p. 1193) published a case in which he had excised the shoulder-joint for a frequently recurring dislocation in a woman, aged 45.

Nothing abnormal, beyond slight grating, could be detected on examination, but, under anaesthesia, a sub-coracoid dislocation could be readily produced, and as readily reduced. At the operation a small part of the anterior rim of the glenoid cavity was absent. The head of the humerus was sawn through the anatomical neck; gentle passive movements were begun three weeks after the operation, and, twelve months later, there had been no recurrence of the dislocation. The arm was then very useful, with good movements, the patient being able to perform her ordinary household duties.

vii. A few cases of growth (*e.g.*, exostosis, chondroma, myxochondroma, myeloid growths, and ossifying sarcoma) connected with the upper extremity of the humerus. Whilst the priceless value of the hand fully justifies the attempt in some instances, such cases must be extremely rare.

Perhaps it is owing to this rarity that this matter has received so little attention.

The best reported English case with which I am acquainted is one in which the late Sir W. Mitchell Banks (*Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 6) endeavoured to save the upper extremity of a patient by excising the upper end of the humerus, the site of a sarcomatous growth originally enchondromatous.

"S. D. was a spare, placid man of 56, a chapel-keeper. So far back as the summer of 1865 he was seized with a violent pain near the right shoulder, and after that came a hardness and swelling at the top of the humerus, which very slowly increased. As it gave him no great inconvenience, he did not heed it much for many years, but by 1878 it had grown to be as big as a cocoa-nut, so that, on attempting to raise the arm, it became locked against the acromion, limiting movement, while pain of a severe character set in. In June, 1878, the tumour was removed by cutting down upon it, and dissecting off the tissues from over it. As it grew from the outer surface of the upper third of the humerus, this was effected without difficulty. Then with a mallet and chisel it was cut cleanly away from the bone, and the surface from which it sprang was thoroughly scraped—a pretty broad surface, by the way. I left no cartilaginous remains that could be seen. The patient rapidly recovered, but in the track of the wound a sinus or two persistently

* The credit of first taking this step is due to Dr. Gerster, of New York.

† Two details in the operative and after-treatment intended to meet this displacement are given at pp. 204, 207.

remained, leading down to the bone. After the lapse of about two years it became clear that the tumour was returning, and by the summer of 1881—three years after the first operation—it had attained an immense size, having taken a fit of growing during the last few months. It clearly arose from the same site as before, but now it filled up the axilla, and had even got beneath the great pectoral. Pain and rapidity of growth demanded its speedy removal. But the removal of a whole right arm at the shoulder-joint seemed such a dreadful thing, that one was anxious to save a hand and forearm by carrying away, if possible, the tumour and upper part of the humerus, even although the upper arm might remain useless. The patient being made well aware that, in case of the failure of this project, there was nothing left but amputation, I attempted it. The incisions necessary to lay bare the tumour were very extensive, the chief one reaching from above the acromion, half-way down the outer side of the upper arm. With much trouble, and after the loss of a great deal of blood, the outer and upper surfaces of the growth were exposed, and the humerus was disarticulated from the scapula. Then, sawing through the humerus, about an inch below the deltoid insertion, I attempted to dissect away the tumour from the brachial vessels and nerves. Here, however, most serious difficulty was encountered, from their intimate incorporation with the growth, and at last, after a prolonged attempt, I was reminded by my colleague, Mr. Harrison, that the patient had plainly endured as much as he could, and that to make further effort might only lead to collapse on the table. I was reluctantly compelled to admit this, and so rapidly swept the limb away at the shoulder. So profound was the shock, that a short time after the operation the temperature fell to 95°, and remained so for many hours. The operation was conducted antiseptically, and the patient, in spite of the loss of blood, made such a rapid recovery that on the twenty-third day he left the infirmary quite well, and remains so now, two years after the amputation. If the great vessels and nerves had not been so seriously enveloped by the growth, the limb would have been saved, although with the loss of the upper half of the humerus. But even a forearm is better than no arm at all. The case also shows that chiselling off cartilaginous tumours is not by any means a certain removal.* The surface that was left upon the humerus, after the first removal of the tumour, looked perfectly healthy to the naked eye, but there must have been cartilage cells deep down in the tissue of the bone."

Mr. Southam (*Med. Chron.*, Jan. 1887, p. 291) has recorded a successful case of resection of the upper end of the right humerus for an endosteal (mixed-cell) sarcoma:

A large deltoid flap was made, and the head and 4 inches of the shaft of the humerus removed. Six months later, the patient, aged 30, could raise her hand to the mouth, and employ her arm for household work and in using a small sewing machine. Though, with the arm hanging by the side, there was an interval of about 4 inches between the acromion and upper end of the humerus, the distance could be considerably diminished by the action of the biceps and triceps, and coraco-brachialis. A good illustration accompanies this instructive case.

M. Ollier (*loc. supra cit.*, t. ii. p. 57) mentions a most interesting case in which, by early intervention, resection of the upper half of the humerus for a sarcoma, central and subperiosteal, saved both the life and the limb of a child, 6½ years old. The growth dated to a fall upon the shoulder, and made its first appearance as a filbert-like swelling close to the insertion of the deltoid. As the swelling increased slowly and resisted treatment, it was explored by M. Heurtaux. The sarcomatous nature of the swelling having been made clear, the upper half of

* The late Sir William, who always wrote instructively, as well as with unusual vigour and terseness, would have been the first to admit that the case also teaches the importance of securing complete primary union. The persistent sinus probably conduced towards the enchondroma becoming sarcomatous.

the humerus was removed, this step being thought safer, though the joint itself was not involved. No enlarged glands could be felt in the axilla. Three years later the condition, locally and generally, was excellent. There was no reproduction of the part removed. The resected end terminated in a small osteophytic prolongation joined to the scapula by a fibrous band. The humerus was thus unable to find any steadying point so essential for its movements. The limb was therefore a flail, but a very useful one, thanks to the mobility of the elbow and fingers, and to a supporting apparatus.

Mr. J. Hutchinson has recorded (*Path. Soc. Trans.*, vol. viii. p. 346) a case of resection of the upper part of the humerus for a large myeloid growth. The following is a summary of the case:

Supposed fracture of the neck of the humerus in a woman, aged 27. Permanent loss of movement and gradual enlargement above the spot. Amputation at the shoulder-joint advised fourteen months after the accident, on account of a large tumour which had formed—refused by the patient. Arrest of the growth for four years. Subsequent rapid growth, and enlargement of the glands. Resection of the upper third of the humerus, and removal of the diseased glands. Recovery, with a useful arm, but rapid reproduction of the disease. Death, five months after the operation, from an enormous mass, with sloughing and bleeding. Secondary growths connected with the bone, axilla, cervical glands, and lung.

Methods.

- i. By an anterior straight incision (Figs. 99, 100, 102 and 103).
- ii. By a posterior incision, straight or curved.
- iii. By a deltoid flap.

The first two only will be referred to at any length here. The third interferes so seriously with the after-power of the deltoid that the indications for its use must be of the rarest.

i. **By Anterior Incision.**—The patient being rolled a little over, and the humerus abducted from the trunk to an angle of 60° or 80°, according to the mobility of the joint, the surgeon, standing at the shoulder facing the body, with an assistant opposite to him, and another seated to manipulate the limb, makes an incision, 3½ inches long, commencing at the base of the coracoid process, and on a level with it, through skin and fasciæ; the interval between the deltoid and great pectoral* is then looked for, and opened up for the same length, retractors inserted, and, if the arm has been rotated outwards, the

* The advantage of an anterior incision starting from just outside the coracoid instead of from the acromion is that the deep incision is made either in the inter-muscular space or through the anterior fibres of the deltoid. In the latter case all the posterior and outer part of the deltoid (so powerful in abduction) is left intact, together with the circumflex vessels and nerve, with the exception of the terminal filaments going to the anterior part of the muscle, which alone is interfered with. M. Ollier (*loc. supra cit.*) prefers the incision through the anterior part of the deltoid, as owing to the varying width of this muscle the above inter-space does not always correspond to the coracoid process, and because the cephalic vein lies between the muscles. Where the soft parts are much swollen and where the arm cannot be abducted so as to bring the deltoid into relief, the operator must take as his landmarks the position of the coracoid process and the junction of the upper and middle third of the shaft of the humerus, and make his incisions carefully. If the incision in the muscular interspace does not sufficiently expose the joint, a flap of deltoid may be turned outwards from its insertion, as in Fig. 82, if vigorous retraction of this muscle does not suffice.

bicipital groove will usually be seen lying at the bottom of the wound.* The condition of this important tendon will vary much: (1) it may be normal; (2) it may be surrounded with tubercular material; (3) it may be frayed and adherent to the bone; (4) it may be ulcerated or absent.

The bicipital tendon having been identified, the capsule is opened by a free incision, the head examined with the finger, and the incision in the capsule next carried downwards along the bone just outside the bicipital groove to the level at which it is proposed to saw the bone. With a sharp-pointed, curved, periosteal elevator (Fig. 66) the three muscles attached to the greater tuberosity are now carefully detached from it. The assistant in charge of the limb by strenuous rotation inwards brings each part of the tuberosity in contact with the elevator. The operator next turns his attention to the lesser tuberosity, the limb being now rotated outwards, and separates the attachment of the subscapularis. The left thumb, aided by retractors, protects the soft parts. The biceps tendon and its sheath, if healthy, are detached bodily with the soft parts and the periosteum on the inner aspect of the incision. If diseased the sheath must be opened, and the tuberculous material removed with curved scissors or a curette while the tendon is carefully held aside with a blunt hook or aneurysm-needle. In detaching the tendons, and also, later on, in sawing the bone, if this be done *in situ*, care must be taken, by keeping the arm somewhat separated from the body, and the elbow a little raised, to relax all the parts of the capsule. Unless this be done, the edges of the wound in the capsule are stretched tight, the finger is nipped, and there is no room for working with a saw, knife, or elevator.

The bone may be divided in two ways:—(1) *In situ* (Fig. 100). A blunt dissector is passed under the bone from within outwards, so as to protect the soft parts; the bone is completely sawn through with a narrow-bladed or a Gigli's saw (Fig. 130, p. 361), seized with lion-forceps, and twisted out, the levering movements of an elevator, or a few touches of the knife, aiding this. The actual bone section (p. 204) should be made so as to remove the worst of the disease; usually it will pass through the tuberosities, any remaining mischief—*e.g.*, in the tuberosities—being thoroughly dealt with by the gouge. (2) The head is first thrust out of the wound by an assistant, who pushes the elbow upwards and backwards and holds the humerus almost vertical, and then sawn off. This method is certainly the easier, but disturbs the soft parts more. The former is perfectly safe, and inflicts less damage on the surrounding tissues; finally, where ankylosis is present, it may be most difficult to thrust the head out.† Sir F. Treves, on the other hand, considered that this method is less precise, that it gives little opportunity of fully examining the parts, and that the tissues around may be damaged by the saw. Whichever plan is adopted, the soft parts should be scrupulously protected. The truncated end of the

* Farabeuf advises, to ensure the bicipital groove being found easily, that the arm be kept midway between abduction and adduction, a position secured by placing the hand (the body being horizontal) on the anterior superior spine.

† In one of M. Ollier's cases, as the head of the humerus was being rotated outwards so as to facilitate the detachment of the subscapularis, the bone, which was very fragile, was broken across just above the condyles. This accident ultimately exercised no untoward influence on the result.

shaft should be carefully rounded off with saw or cutting-forceps, especially in the neighbourhood of the nerves, and Mr Sheild's plan of trying to reproduce the shape of the old head may be adopted.

ii. As tuberculous disease of this joint, which alone is likely to need access to every part, is not common, and as the anterior method by a free incision and the careful use of retractors allows of sufficient exposure of the parts operated upon, I have hitherto practised this method alone. The excellent results obtainable by Prof. Kocher's **posterior curved incision** more than justify a trial of his method. Prof. Kocher figures a patient who, after excision of the head of the humerus by the above method, was able to raise the arm vertically by the side of his head. The operation was here performed for fracture through the tuberosities with rotation of the head of the humerus. The skin incision is carried from the acromio-clavicular joint over the top of the shoulder and along the upper border of the acromion to the outer part of the spine of the scapula, and from thence downwards in a curved direction towards the posterior fold of the axilla, ending two fingers' breadth above it. The upper limb of the incision passes through the superior ligament right into the acromio-clavicular joint (the strong fibres of which are divided), and in the rest of its course divides the insertion of the trapezius along the upper border of the spine of the scapula. The descending limb of the incision divides the dense fascia at the posterior border of the deltoid, and exposes the fibres of the latter. The thumb is now introduced beneath the smooth under-surface of the deltoid, so as to separate it from the deeper muscles (with which it is connected merely by loose cellular tissue) up to its origin from the acromion, and its posterior fibres are divided. The finger is now carried along the upper border of the infraspinatus muscle, so as to free it opposite the outer border of the spine and the root of the acromion. In a similar manner the supraspinatus is detached with a blunt dissector from the upper border of the spine of the scapula, in order that the finger may be passed from above underneath the root of the acromion. The root of the acromion, which is now freed, is chiselled through obliquely, and, along with the deltoid, is forcibly pushed forwards with the thumbs over the head of the humerus. In chiselling through the bone, care must be taken not to injure the suprascapular nerve which passes under the muscles from the supraspinous into the infraspinous fossa; the nerve is also protected by the transverse ligament of the scapula. It is desirable, before chiselling the bone, to bore the holes required for the subsequent suture. Instead of dividing the root of the acromion, the formation of the posterior flap may be simplified by merely detaching the scapular origin of the deltoid subcortically; this allows of very firm union subsequently. After reflecting the acromio-deltoid flap, the head of the bone is readily accessible in its upper, outer, and posterior aspects, covered by the tendons of the external rotators, viz., the supraspinatus, infraspinatus, and teres minor muscles. The posterior surfaces of these muscles are also exposed. An incision is now made over the head of the bone, and, in order to avoid unnecessary injury, this must be done accurately. The arm being rotated outwards, a longitudinal incision is carried down to the bone in the coronal plane. Commencing at the upper part of the posterior lip of the bicipital groove,

it extends upwards through the capsule along the anterior edge of the insertions of the external rotator muscles and over the highest part of the head of the humerus, so as to expose the tendon of the biceps as far as its attachment to the upper edge of the glenoid cavity. The insertions of the external rotators are now separated from the greater tuberosity and drawn backwards. The biceps tendon is freed from its groove and drawn forwards, so that its sheath may be inspected. The whole procedure is made easier by carrying the elbow forwards, and at the same time rotating the arm outwards. In this way the entire head of the humerus and the glenoid fossa can be freely exposed, and, if it is not necessary to do a complete excision, the anterior wall of the capsule and the insertions of the anterior muscles can be preserved. In other cases the insertion of the subscapularis into the lesser tuberosity is detached upwards and inwards. The circumflex vessels and nerve which come out from under the teres minor can be preserved; indeed, if the operation be properly performed, there need be no fear of injuring them. When the head has been thoroughly cleared, and especially if it be excised, an excellent view of the glenoid cavity is obtained, much better than is possible by the anterior incision; and as it is most important to remove all the infected tissues in tuberculous disease, this complete exposure of all parts of the joint is the great advantage of the method. Moreover, this free exposure is obtained without interfering with the function of the deltoid or other muscles of the shoulder. Yet another advantage over the anterior method is, that when the disease in the head is limited or absent, only the posterior muscles require to be separated, while the anterior part of the capsule, the coraco-humeral band, and the subscapularis muscle are preserved intact, and in this way there is no tendency of the head of the bone to be displaced upwards towards the coracoid, which so frequently occurs as the result of the anterior operation. The method is, therefore, especially valuable in partial arthrectomies.

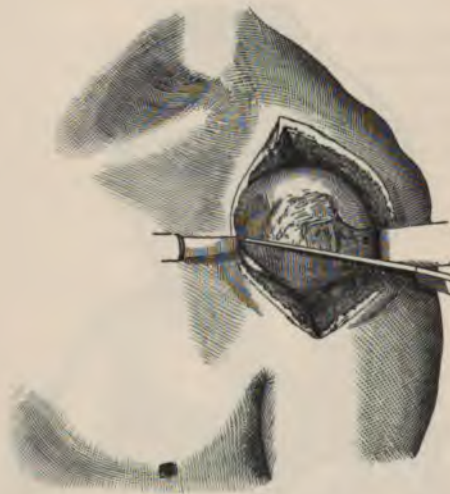
iii. **The Deltoid Flap** gives more room, and thus facilitates the operation considerably, but the larger scar, and far greater, in fact almost total, impairment of deltoid power, are such serious drawbacks* that it is, nowadays, hardly ever used. If the head of the humerus is very much shattered, if the soft parts are much matted and thickened, if there is any special reason for completing the operation rapidly, in the rare cases of excision attempted for large growths, for the sake of more complete exposure (p. 200), this method may, though very seldom, be made use of.

SITE OF SECTION OF THE BONE (Fig. 100).—It being most important to leave the humerus as long as possible, not an atom more than is needful should be removed. The section should be made just below the articular surface in every case where this will remove the whole of

* Prof. Longmore (*loc. supra cit.*, p. 9) says that at one time there were at Fort Pitt two patients, in each of whom resection of the joint had been performed, in one by the longitudinal, in the other by the flap-incision. In the former case the patient could raise, without difficulty, $\frac{3}{4}$ hundredweight with the arm in an extended position by his side, and hold 14 pounds in his hand when the arm was flexed. In the latter case, all the movements of the joint were very seriously impaired. The man could not, in any degree whatever, move the arm from the side himself, nor could he flex the forearm upon the upper arm without support from the other hand.

the disease, and where all the head must go. The advantages of sawing here over division through the surgical neck are—(1) A longer humerus is left to be brought against the glenoid cavity, and aid, as a fulcrum, the action of the deltoid in elevating the arm. (2) The section is made within the capsule, after, of course, freely opening this, but not damaging its attachments to the neck of the bone. (3) The tendon in the bicipital groove is less likely to be interfered with. In every case of excision, save the rare one for new growths, I would advise my readers to begin by removing as little as possible, then plugging the wound with sterilised gauze to test the freedom in abduction, rotation, &c., of the

FIG. 100.



humerus, and only to resort to further removal of bone if the mobility is much restricted.

The late Mr. Davies-Colley has related (*Guy's Hosp. Rep.*, third series, vol. xx. p. 525) a case of partial resection followed by unimpaired movement of the joint.

As, at the time of the operation, a portion of the head of the humerus seemed healthy, and the disease consisted chiefly of a carious erosion of the great tuberosity and the adjacent portion of the articular surface, these portions only were removed, without dislocating the head of the bone. The part removed was chiefly the articular surface above the greater tuberosity, together with what remained of that process. The lesser tuberosity appears not to have been touched. About three-fifths of the articular surface was left, being healthy. There was some erosion of the bone below the epiphysal line, but the greater part of the disease was situated in the epiphysis. The section of the bone was hard. Seven months later the movement of the joint was "perfect in every direction. He swings the arm round above his head, and rotates it, and performs every action with as great freedom and rapidity as with the left shoulder-joint."

If the disease extends lower down, gouging may be resorted to, or, if needful, one or two further sections* may be made till healthy tissue

* In cases of gunshot injury, splinters of head or shaft may have to be carefully removed, and the point determined whether the shaft is extensively split towards the

is reached, but, as in the case of the elbow, periosteal deposits or roughenings, which will subside when the irritation is removed, must not be mistaken for disease which calls for extirpation.

The glenoid cavity is then examined, and gouged, or its cartilage peeled off with a blunt knife, if carious. Cases where its complete removal is called for must be most rare. If really called for, it may be effected by an osteotome, fine sharp saw, or cutting bone-forceps, after the glenoid insertion of the capsule has been peeled off to a sufficiently high level; but taking away the glenoid cavity must interfere with the

FIG. 101.



The above represents a fair average amount of movement, such as may be expected after excision in children, in whom the securing of adequate active and passive movement is always difficult. The disease was tubercular mischief in the upper epiphysis. Numerous sinuses were present in front and in the axilla.

attachments of the biceps and triceps, and cause risk by the opening up of additional cancellous tissue.

The above operation must be somewhat modified in cases of ankylosis and new growths (pp. 193, 199). In cases of bony ankylosis the operator may adopt one of the two following courses: he may divide with a chisel or gouge the line of fusion, and then, the humerus being movable on the scapula, complete the operation on the lines already given; or, having sawn through the humerus *in situ*, he may seize the bone with lion-forceps, or drill a hole and insert McBurney's hook, and

elbow. This is often very difficult to determine, because a longitudinally fractured shaft may be maintained in an apparently unfractured condition by the close apposition of the fragments, and by the periosteum, &c.

strip it out of its periosteo-capsular covering. Much care must be taken to put the humerus freely through its different movements before it is decided that sufficient bone has been removed,* lest ankylosis recur. I would refer my readers also to the remarks at p. 193.

In those rare cases of resection of the upper end of the humerus for new growths (p. 199), the operation must be outside the periosteum, and the vessels and nerves will require additional attention. More room will be required now, and, to gain this, the pectoralis major and deltoid may each be detached from the clavicle. The shoulder-joint itself is very rarely invaded by the growth. Owing to the free removal of the humerus which is necessary, the after-result is often imperfect, though, if the insertion of the deltoid can be preserved, the limb will still be very useful.

Any vessels which require it, *e.g.*, branches of the circumflex arteries, are then secured, sinuses are laid open, tuberculous tissue, any remnants of diseased capsule and synovial membrane removed, and the sub-deltoid bursa, if involved, dissected out, drainage provided, and the upper part of the wound closed. The drainage-tube should pass from the lowest part of the wound in front (whether this be within or below the capsule), by means of a counter-puncture, to the back of the upper arm, so that the site of the operation may be well drained while the patient is recumbent. In making the counter-puncture, from within outwards, the close contiguity of the circumflex vessels and nerve must be remembered.†

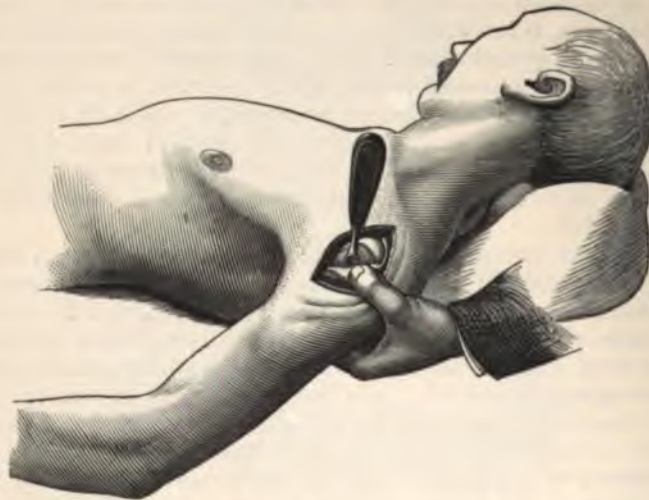
Where excision has been performed for tuberculous disease, iodoform emulsion, and small tampons of iodoform gauze which has been kept in a solution of carbolic acid (1 in 20) or lysol (2 p.c.) will be employed, and the same will be made use of in cases where oozing is expected. The gauze thus used fulfils also the end of opening out the capsule, and encouraging, aseptically, the bone-producing property of the detached periosteum (Ollier). At other times, where the tissues are healthy, the above tampons will be much less needed, and the wound may be sutured in the upper part. In every case a triangular pad of sterilised gauze, 3 or 4 inches thick at its base, should be placed in the axilla, and the arm carefully secured to the side, the elbow being kept a little forward, and comfortably retained away from the thorax by a sufficiently thick layer of salicylic wool. The first dressing should not be changed for five or six days, if possible, especially in children. After the first dressing, the limb should not be fastened to the side, the forearm only being supported in a sling. The tendency to displacement forwards must be met by a firm pad over the front of the joint. The axillary pad is of the greatest importance and should be worn for six weeks. Otherwise, a limb fixed to the side is almost certain. Where the parts are lax as after a recurrent dislocation, or

* In young subjects the epiphysal cartilage must be left undamaged, if possible.

† At least two cases of fatal injury to the circumflex artery have been recorded. One is given by Gurlt (*Obs.* 175, p. 750), the other by Prof. Annandale (*Med. Times and Gaz.*, May 29, 1875). In the latter the incision which exposed the head of the bone divided the posterior circumflex artery so close to the main trunk that the operator was obliged to tie that vessel above and below the opening. Gangrene followed, necessitating amputation, and the patient, æt. 62, died.

when, as in old tuberculous disease, the necessary interference with the bone, attachments of tendons, &c., has been extensive, less liberty must be given, or the new joint will be too loose. While the fingers and elbow-joint must be gently exercised daily from the very first, the date of commencing movements of the shoulder-joint will depend on the lesion for which the operation was performed, and the condition of the parts around. Where these are healthy, when but little bone has been removed, where it is probable that new bone will be quickly reproduced, the date must be an early one. As a general rule it is of no use to begin before the deep parts of the wound are sufficiently healed; and this should be some time between the second and third weeks. The chief points to pay attention to are—(1) Care in carrying out abduction, lest the new head of the

FIG. 102.



Separation of the periosteum from the great tuberosity, the arm being turned inwards. The blunt dissector is that of M. Farabeuf (Fig. 66). (Farabeuf.)

bone be lodged close to the coracoid process instead of in the glenoid cavity; (2) Massage and electricity to the muscles, especially the deltoid and the muscles attached to the tuberosities; (3) Exercise of the rotator muscles; (4) Making the patient carry out the movements of his humerus independently of those of the scapula—an end very difficult to ensure in the case of a child or in cases where ankylosis has long existed. The above must be daily and assiduously carried out, with the occasional aid of an anæsthetic if needful.

The practice of such movements as bringing a gun up to the shoulder, sweeping with a short brush, lifting and carrying light weights with the limb abducted, are valuable aids.

QUESTION OF SUBPERIOSTEAL RESECTION (Figs. 102 and 103).—As one of the chief drawbacks of the operation is the poor amount of abduction and elevation which remains, owing, in large measure, to the humerus being too short to be brought into the glenoid cavity when the

deltoid acts, I would urge very strongly that in this joint a trial of the subperiosteal method should be carefully made, to ensure as much reproduction of bone as possible. Von Langenbeck (*Arch. f. klin. Chir.*, 1874, vol. xvi.) gives more than one case in which the arm could be raised vertically, and the movements were excellent. While it is true that these were cases of resection for gunshot injury, and therefore the patients probably healthy adults, on the other hand preservation of the periosteum is not likely to be so easily effected here as in those cases where it is softened by disease. Even if the periosteum cannot be completely preserved, an additional half-inch or inch in length gained, and an irregular knob or nodule-like mass which may be moulded into a rudimentary head within the new capsule, may make much difference in the future mobility and usefulness of the limb.

FIG. 103.



Separation of the periosteum from the lesser tuberosity, the arm being turned outwards. (Farabeuf.)

M. Ollier (*loc. supra cit.*, t. i. p. 35, t. ii. p. 85) figures and describes a specimen of a resected humerus, nine years after the operation.

The patient, æt. 26, had had mischief in the joint for three years, with, latterly, suppuration and five fistulæ. Five centimetres of the humerus, measured from the summit of the head, were removed. After the operation he was able to follow his work as a hawker, and to use both arms equally well in lifting weights. The upper end of the humerus was irregularly expanded, showing numerous bosses and depressions into which the insertion of the capsule and different muscles could be followed.

AMOUNT OF BONE THAT MAY BE REMOVED.—This will mainly depend upon the amount of damage done to the periosteum, the possibility of retaining it entire, and the age of the patient.

Dr. MacLaren (*Lancet*, June 7, 1873) removed the head and $3\frac{1}{2}$ inches of the upper end of the humerus with an excellent result.

Langenbeck mentions a case in which the whole shaft of the humerus necrosed.

This was removed, the elbow-joint being resected at the same time, and yet the reproduction of bone was so complete that the shortening was no more than $1\frac{1}{2}$ inch. The patient was young, and growth went on, though the bone remained behind its fellow. The new humerus broke several times, but the movements of the shoulder and elbow were ultimately very satisfactory, and the hand was capable of most delicate movements.

Prof. Billroth (*Wien. Med. Blätt.*, March 20, 1884; *Lond. Med. Rec.*, 1884, p. 197) gives the case of a patient, aged 20, in whom the whole of the right humerus was removed when he was 12.

Though the periosteum was carefully left intact, the bone did not form again. Yet the forearm was well developed, and by means of an ingenious splint and an artificial shoulder-joint, the patient could use his arm and hand well.

Excision of Shoulder in Military Surgery.—The following points of practical importance are taken mainly from the *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 519 *et seq.* While these statistics may appear unreliable, gathered before the era of antiseptic surgery, it is not improbable that in any great campaign, where large numbers of wounded with other gunshot injuries than those of small bullets of high velocity have to be treated at short notice, surgical history may repeat itself. Dr. Otis here draws conclusions from the histories of 885 cases, 670 being for direct injury, and 215 for fractures in near proximity to the joint or for consecutive caries or necrosis.

Excision of the head of the humerus, together with portions of the clavicle and scapula—*e.g.*, acromion, spine, coracoid process, glenoid cavity—was performed in 42 cases.

It is remarkable that the mortality is less in this group than in that of simple removal. The following remarks are quoted from Loeffler:—Fracture of the glenoid cavity is especially frequent in shot-injuries of the shoulder. This complication makes the prognosis of excision more serious, but is not a contraindication. If only fissures are present, the glenoid cavity should not be removed. Tedious burrowing of pus is very likely in these cases.

Partial excision of the head of the humerus was done in 14 cases.

The results do not prove that, when the head of the humerus is grooved or grazed by a ball, it is safer to slice off the injured part rather than to decapitate the bone. Ankylosis was too frequent to permit much to be said in favour of partial excision in this region.

Date of excision of shoulder.

The *primary* cases were 273, the *intermediate* 55 in number, the results being far less satisfactory than in the primary, "and corroborating the general rule forbidding operations during the inflammatory stage after injury, except under circumstances of exceptional urgency." The mortality was twice as great as in the primary, and nearly 12 per cent. greater than in the following. *Secondary*, 26 cases, with a mortality of 50 per cent. The greater success of primary excision can well be understood. The condition of the soft parts is much more favourable. There is no infiltration or burrowing of pus, no softening of parts or degeneration of muscles, no caries or osteitis—none, in fact, of those complications which, in secondary excision, imperil the life of the patient and the usefulness of his limb.*

* Dr. Otis quotes Rupprecht, one of the German authorities in the war of 1871, to the same effect:—"The secondary operations were very much aggravated by deformities, gradually appearing after the injury, through thickening of the periosteum especially, and by extensive cavities succeeding abscesses. Immediately after the operation even, healing was retarded by pus-formations, sometimes under the clavicle, in other instances under the scapula, again on the anterior aspect of the arm. Aside from the greater muscular atrophy due to debility resulting from antecedent tedious suppurations, and to pain and loss of sleep; apart, also, from the abundant granulations attending secondary

Excision of the head and portions of the shaft of the humerus as well was performed in 293 cases, in 190 of which the precise length of bone excised was specified.

Thus, in twenty-three, 4 inches; in eleven, $4\frac{1}{2}$ inches; in seven, 5; in two, $5\frac{1}{2}$; and in five, 7 or 8 inches were excised. While the arm was shortened (there being very rarely any restoration of bone) and feeble, the forearm and hand were usually most useful. Where the arm was flexible and uncontrollable, an auxiliary apparatus, such as the ingenious ones of Dr. Hudson (*loc. supra cit.*, Figs. 449, 453), brought about usually a great improvement.

Dr. Otis (*loc. supra cit.*, p. 611) states of shot-injury resections:—"In the majority of cases that I have examined, motion in flexion, extension, and adduction was tolerably well preserved. I have met with no instance of true ankylosis. In a large proportion of the cases, the functions of the forearm and hand were but slightly, and in many not at all, impaired. Those who argue that the limb is useless after an excision at the shoulder, because it dangles by the side, display a superficial appreciation of the considerations to be taken into account. Apart from the inestimable value of even a partial use of the hand, the mere weight of the limb, though its motor functions be completely destroyed, is of advantage in preserving the equilibrium of the body, and avoiding the distressing deformity consequent on ablation."

The following advice of Prof. Ollier as to the treatment of gunshot and other injuries of the shoulder-joint will be found most useful.

If the head only be fractured, and not in more than two or three fragments, and if these are held together and not widely separated, he would trust to antiseptics. If suppuration occurred, he would advise resection; and he points out that a deferred excision has one advantage, *i.e.*, that time may have elapsed for inflammation of the periosteum to have occurred, and thus its osteogenetic properties may be aroused. If the head of the humerus be badly shattered, and the fragments much separated from each other and from their periosteum, he would perform a primary excision, endeavouring to reshape the extremity into a new head. If the splintering and damage to the bone does not affect more than three or four centimetres of it, all the damaged bone may be resected; but if the mischief extends lower down, some risk must be run and the injured bone left. And his course would be the same in the case of a compound fracture of the neck of the humerus with dislocation. If part of the head had escaped splintering, he would leave this attached to the shaft. Removal of splinters Prof. Ollier directs to be done with the greatest care of the periosteum, every atom of this being left in the wound. While bullet-wounds may be used for drainage, it is rarely well to enlarge them or to throw one into another so as to employ them as the operation wound; this should be made in the usual place. With regard to the comparative value of primary and later excision, Prof. Ollier allows that bone production is less likely in the former owing to the periosteum being uninfamed and more difficult to save. On the other hand, he points out that, as yet, we scarcely know what antiseptic precautions and the use of proper periosteal elevators will effect. Moreover, in primary resection for gunshot injuries the patients are usually young adults, and their muscles in excellent order.

In the case of gunshot and other injuries in which the damage is not limited to the head and surgical neck of the humerus, but splinters the upper half or three-quarters of the humerus, resection is still urged by Prof. Ollier (*vide supra*) as long as the soft parts are sufficiently sound to survive. Though the functions of a limb thus preserved will be very imperfect, the result will be far superior to that of amputation at the shoulder-joint. In any such resection the antiseptic precautions should be as complete as possible, and any long splinters, which, however much the bone be shattered, preserve their relation to the periosteum, should be left, as, with the aid of the bone production of the periosteum around them, they will maintain the continuity of the bony column.

Mr. G. H. Makins, C.B. (*Surgical Experiences in South Africa*, 1899—1900, p. 236) gives the following experience of the results of small bullets of high velocity: "Wounds

operations, and resulting prejudicially in regard to the future usefulness of the limb, the disadvantages of secondary operations already adduced were of sufficient importance to permit us to declare that primary resection of the shoulder-joint is preferable to the secondary operation."

of this articulation were by no means common. This depended, I think, on two points in the architecture of the joint: first, a bullet to enter the front of the cavity and traverse the joint needed to come with a great exactitude from the immediate front; secondly, wounds received from a purely lateral direction calculated to pierce the head of the humerus and the glenoid cavity were naturally of very rare occurrence. Wounds of the prominent tip of the shoulder received while the men were in the prone position were not uncommon, but it was remarkable how rarely the shoulder-joint was implicated in these. The question of the narrow nature of the cleft exposed also comes up in this position. As far as my experience went, injuries to the lower portion of the capsule accompanying wounds of the axilla were those most often met with. The ease and neatness with which pure perforations of the head of the humerus can be produced was also an important element in the frequent escape of this joint. No case of fracture of the glenoid cavity happened to come under my notice. I saw few instances in which the joint needed incision, and cannot recall or find in my notes any case in which serious trouble arose."

SURGICAL INTERFERENCE IN SEPARATION OF THE UPPER EPIPHYSIS OF THE HUMERUS.

This is often a difficult lesion to treat. Under certain circumstances, operative interference, with the safety that modern precautions, duly carried out, give nowadays, should be resorted to. We may divide the cases that call for it into the following groups:—A. **Cases of Simple Injury.** B. **Cases of Compound Injury.**

A. **Simple.**—These may be further divided into—i. Those of recent date. ii. Those of long standing.

i. **Simple Cases of Separation of the Epiphysis of recent date.**—Here interference is justified when there is very great difficulty in effecting reduction owing to complete separation of the two parts, aided by the rotation of the epiphysis and the very small size of the upper fragment. Mr. Poland, in his *Traumatic Separation of Epiphyses* (p. 226)—one of the most striking works on surgery which have ever appeared in any language, and a mine of wealth as far as its lucid, complete, and helpful instruction goes—states that "one of the chief difficulties in reduction occurs from the insertion between the epiphysal fragments of bands of periosteum, fascia or muscle, or from the penetration of the periosteal sheath by the diaphysal end." Other cases are those where, if the displacement is corrected, there is much difficulty in maintaining the reduction when a sharp portion of the lower fragment, having penetrated the deltoid, is projecting under the skin, and when there is evidence of pressure on the vessels and nerves.

The operation should be performed on some such lines as these. An incision is made freely in the interval between the pectoral and deltoid; the cephalic vein is drawn aside or tied between double ligatures. The soft parts having been widely retracted, the ends of the two fragments are next identified and examined, any rent in the periosteum being carefully enlarged if needful. It will now be found possible, in some cases, to replace the fragments in position, as they will remain in contact after any folded-in fibres of muscle or periosteum have been removed. The edges of the rent in the periosteum and capsule should be carefully sutured, and it may be well to draw together with buried sutures of sterilised silk any opened-up periarticular planes of connective tissue. Where the fragments do not come readily into position, it will be needful to remove any projection from the lower fragment. If

there is any difficulty in retaining the fragments in position it will be well to wire them together, the wire being hammered down *in situ* (p. 129.) The question of the use of drainage will depend upon the degree of disturbance of the parts, the amount of probable oozing, &c.

In those cases where the epiphysial head is not only separated, but dislocated owing to the severity of the injury having lacerated the capsule freely, Poland (*loc. supra cit.*, p. 243) advises as follows:—

"Seeing that it is almost impossible to reduce the head of the bone in these extremely rare cases, an incision should be made, with antiseptic precautions, through the skin and deltoid down to the seat of separation, and the epiphysis replaced in position. It will be found necessary to open the capsule of the shoulder-joint before the epiphysis can be reduced. This should be accomplished by direct manipulation of the head into its place by pressure of the thumb and fingers, or by means of a traction-hook (Fig. 98) inserted into a hole drilled in it after the method advocated by McBurney (*Ann. of Surg.*, April 1894, p. 408). The fragments should then be fastened together in their normal position by means of pegs or sutures."

ii. **Cases of older date.**—Here, where some weeks or months have elapsed, interference may be called for, owing to the limitation of movement, especially as regards abduction, elevation, and rotation, brought about by the overlapping of the fragments, their union in a faulty position, and the projecting callus. Here, after exposure of the seat of union, and free retraction of the soft parts, the surgeon will have to follow the advice of M. C. Walther (*Rev. d'Orthop.*, Jan., 1897, p. 43, quoted by Poland, *loc. supra cit.*, p. 240), and decide between the necessity of completely resecting the callus in order to place the fragments absolutely in position, or to freely remove any projecting ends of the diaphysial fragment, and plane away any excessive callus.

B. Compound Cases.—Here resection of the projecting end of the diaphysis will usually be required before reduction can be effected, a step that will facilitate the thorough cleansing of the parts which is so much required. Wiring with sufficiently stout wire, and suture of the rent in the periosteum, will be required, as already indicated above. About three weeks after any of these operations, passive movement should be begun, and perseveringly continued, together with friction and massage.

CHAPTER VII.

REMOVAL OF THE SCAPULA.

Indications.

1. New growths. 2. Caries. 3. Accidents — *e.g.*, railway and machinery accidents.

1. As it is the first of the above which chiefly raise the question of removal of the bone, and which present the greatest difficulties, it is to removal of the scapula for new growths that most of the following remarks will apply.

A. Partial Removal of the Scapula.—In a very few cases (*e.g.*, where the surgeon, operating on an exostosis, is uncertain as to the nature of its base and does not feel satisfied with gouging this, or where he is certain that he is dealing with an unmixed enchondroma in an early stage) partial removal of the bone may be sufficient. The chief essential points here are (1) to freely expose the growth by appropriate flaps, so that the limits may be clearly defined; (2) to be provided with reliable instruments of keen temper, owing to the exceeding hardness which may be met with here.

While some Continental writers* have given elaborate directions for partial removal of the scapula, it is only in the above very few cases that this operation is likely to be used by English surgeons. Mr. Pollock, in his paper† on two cases of removal of the scapula, thus advises on this matter: "If a portion of the scapula be removed, it should only be the lower portion. But even if this be attempted, the loss of blood would probably be much greater than if the whole bone were removed; for the wound is more confined, and the wounded arteries are more apt to retract behind the bone above, and offer great obstacles to their being secured. However, should the lower angle be alone the seat of disease, the attempt to remove the lower portion only is justifiable." It must, however, be borne in mind that, when a bone is once the seat of disease which requires removal, the disease is very apt to recur in the portion left, and less liable to do so if the whole bone be removed.

The above remarks of Mr. Pollock are entirely borne out by the histories of cases which have been watched after partial removal of the scapula for any growth save an exostosis.

Thus, in January, 1865, Sir W. Fergusson (*Lancet*, vol. ii. 1865, p. 591) removed the lower two-thirds of the scapula for a sarcomatous growth. Recurrence took place, and, in the following November the rest of the scapula, the greater part of the clavicle, and the upper extremity were taken away.

* *E.g.*, M. A. Demandré, *Des Tumeurs de l'Omoplate* (Paris, 1873).

† *St. George's Hosp. Rep.*, vol. iv. p. 236.

Dr. Bird, of Stockport (*Lancet*, vol. ii. 1865, p. 696), removed the lower two-thirds of the scapula for a growth the size of an orange in the infraspinous fossa, in a child aged 10, the bone being sawn through behind the neck in a line with the supra-scapular notch. A year and a half later the growth recurred and grew quickly, the rest of the scapula being now taken away together with the head of the humerus, which had become adherent to the scapula, and thus also required removal. A year and a half later the child remained well, the use of the hand "in sewing and writing being very little impaired."

When in doubt as to partial or complete removal of the scapula in a case of enchondroma, the surgeon will be chiefly guided by the duration and rate of progress of the growth, its density, how far it is strictly localised, and whether there is any evidence of adjacent nodules of cartilage, pointing to an infection of the medulla.

B. Removal of the Entire Scapula by itself (*e.g.*, cases where the growth is primary from the scapula, and where there is no extension to the humerus or into the axilla.*—Preparations against shock should be taken, the extremities being bandaged in cotton-wool, the head kept low, ether given, and subcutaneous injections of ether and brandy, and the materials needful for injection of saline solution (p. 141) being in readiness. The patient is placed at the edge of the table and rolled over to the opposite side. If the growth is very vascular, or the patient weakly, pressure on the subclavian, if effectual, may help; or if, from the extension of the growth, this is rendered difficult, it may be effected by making an incision down to and through the deep fascia over the artery itself, in order to enable an assistant to put his thumb or finger directly upon it.† This may be done by a separate incision, or by an extension of that by which the clavicle is divided. But as the movements of the limb may easily dislodge the assistant's finger, the operator will do better to trust to plenty of Spencer Wells's forceps, and tying these off in batches of four or five. Great assistance will be given by the preliminary ligature of the subscapular artery recommended by Mr. Watson Cheyne, C.B.

This authority has made use of a preliminary anterior incision in removal of the scapula for a large enchondroma which filled up the

* In cases where the question lies between removal of the scapula and interscapulo-thoracic amputation, J. J. Buchanan, who has considered fully the three operations of partial and complete removal of the scapula and interscapulo-thoracic amputation (*Philadelphia Medical Journal*, 1900), advises that the proposal of Jennel (*Le Mid. Méd.*, 1895, t. i. p. 251) be followed. "In every case in which it is suspected that the axillary vessels and nerves may be involved in a growth of the scapula, the operation should be so conducted that it may, if desirable, be converted into a formal interscapulo-thoracic amputation. He makes the posterior and clavicular incision of Berger, divides the clavicular and acromial attachments of the deltoid, and through this incision makes a digital examination of the relation of the growth to the vessels and nerves. If satisfactory information cannot be thus gained, he resects the external third of the clavicle, separates the muscular attachments to the coracoid, and thus gains better access to the vessels and nerves." Probably it would be surer and safer to follow Berger, and in all doubtful cases to begin with resection of the clavicle.

† As adopted by Prof. Syme in performing the old operation in a case of axillary aneurysm, p. 175. If the clavicle is going to be removed, the subclavian can be commanded by cutting down on the clavicle, freeing it from its attachments in its inner third, passing a flat director carefully beneath it, sawing through the bone here, and removing a portion of it, the finger being thus placed directly on the subclavian (Jeaffreson, *Lancet*, 1874, vol. i. p. 759).

axilla, "projecting the pectoralis forwards to a marked degree," an incision which he recommends in all cases (*King's College Hosp. Rep.*, vol. ii. p. 83; *Clin. Soc. Trans.*, 1895, vol. xxviii. p. 284). In the first instance an incision was made, beginning below at the junction of the axillary and brachial vessels, and running up in the line of the former, so that the axilla is freely opened in its whole extent. The anterior fold of the axilla is raised so as to expose the coracoid process; the three muscles attached to this are next divided with blunt-pointed scissors kept close to the bone. This fully exposes the axillary artery, and its subscapular branch is at once ligatured. "The patient was then turned over, and the operation was completed in the ordinary way. . . . The ligature of the subscapular artery answered admirably. In this case the patient lost extremely little blood, probably not more than an ounce altogether. The detachment of the muscles attached to the coracoid process also enabled the operation to be completed very rapidly, for after the posterior scapular muscles had been divided, and the trapezius and the deltoid had been raised, the acromio-clavicular joint and the muscles going to the head of the humerus were practically the only things which had to be divided."

The patient being turned over, flaps are quickly and freely turned back, usually by a T-shaped incision, one limb running from the acromio-clavicular joint inwards to the superior angle of the scapula, while the other and longer is made at right angles to the first down to the angle of the scapula. In another case the surgeon may prefer to make an incision along the vertebral border of the scapula, and the other at right angles to it across the centre of the growth.* In either case care must be taken not to open the capsule of the growth.

When the whole mass is thoroughly exposed, the trapezius and deltoid are first severed, the arm being pulled away from the trunk. The levator anguli and the rhomboidei are next cut through,† the posterior scapular artery secured, and the serratus magnus divided, being first made tense by lifting the scapula off the ribs upwards and outwards. The muscles on the upper border are now‡ attacked—viz., any remains of the deltoid, the omo-hyoid, and the supra-spinatus—and the supra-scapular artery secured. The acromio-clavicular joint is next opened, or else the acromion or clavicle,§

* If the skin is involved or ulcerated, the flaps must be so shaped as to isolate this.

† It is a bad sign if any of the muscles severed are infiltrated with growth. That this, however, is not incompatible with a good recovery is shown by the second of Prof. Syme's cases (*Excision of the Scapula*, p. 28), in which it is stated that "the tumour weighed between 4 and 5 pounds; it had a soft consistence and a very suspicious aspect, which was strengthened by microscopical examination, as the muscular substance that was taken away along with the growth appeared to be loaded with the germs of future disease; but fifteen months having elapsed since the operation was performed, without the slightest appearance of relapse, it may be hoped that the recovery will prove permanent." On this point I would refer my readers to the case of mine at p. 219.

‡ If the upper border can be taken before the axillary one is dealt with, the subclavian can be better controlled when the subscapular artery (a source of free hæmorrhage) is severed. But this vessel should have been secured by Mr. Cheyne's preliminary incision.

§ Prof. Spence (*Edin. Med. Journ.*, Aug. 1872, p. 178) recommends that the clavicle should be left, not sawn through, otherwise the head of the humerus tends to project through the incision, there being nothing but skin left, the overhanging arch of bone

according to the extension of the growth in this direction, severed by bone-forceps or a narrow saw. If the acromion can be safely left, the resulting deformity—viz., dropping of the shoulder and entire loss of the action of the trapezius—will be lessened.

The lower angle being freed and the latissimus dorsi (if involved) resected, the scapula can now be dragged away from the chest by slipping two or three fingers over the upper or vertebral border. Thus, by tilting the scapula outwards, the axillary border can be inspected, the teres and infraspinatus muscles severed, the position of the subscapular artery defined by a finger passed beneath it, and care taken that this vessel, already tied by the preliminary incision, remains safely secured. The scapula being still further pulled away from the chest, the muscles attached to the coracoid process will be seen severed, and the scapula is removed by cutting into the shoulder-joint and severing the capsular tendons and the biceps and triceps. The coracoid process may become detached at this stage if partially eroded by extension of the growth, or if the patient be young. If this happen, it must be carefully dissected out afterwards.* The different arteries, besides the subscapular, must be secured, if possible, before they are cut. Too many Spencer Wells's forceps must not be left on at one time, or they will be found to interfere with the needful manipulation of the bone. Every vessel must be thoroughly secured by ligature; otherwise, oozing is very likely to take place a few hours later.†

Hæmorrhage may be best avoided by attention to the following points: (1) Making use of Mr. Watson Cheyne's method, and securing the subscapular artery early. (2) Where this method is not available, a trial of adequate pressure on the subclavian, this being effected by a special incision, if needful, to command the vessel. Reasons for not trusting to this have been given at p. 215. (3) Dealing with the axillary border and subscapular artery last. (4) In any case, rapid use of knife or scissors by the operator, aided by intelligent help from assistants in securing bleeding points, and from an anæsthetist who will not

having been removed. On the other hand, sawing the clavicle, while it leaves a cut surface of bone as a possible source of irritation, facilitates the operation somewhat, as it exposes better the large vessels and the muscles attached to the coracoid process.

* If the growth has involved the axillary vessels and nerves, this outlying portion may be dealt with later on, after the main mass has been separated and removed. If it is desired to remove this extension of the disease now while in continuity with the scapular growth itself, the surgeon will have both his hands free for what is a troublesome dissection, by asking an assistant to drag the main mass strongly backwards. To facilitate this step, Prof. Syme (*loc. supra cit.* p. 26) placed a piece of cord round the divided extremity of the clavicle, for the assistant to pull upon. The greatest care must be taken, when dealing with projections into the axilla, to keep the knife, or blunt dissector, as close as is safe to the growth, for fear of opening the large vessels. Large flexible copper retractors should also be at hand. But it will be well, in cases where there is evidence of the scapular growth having encroached upon the large vessels and nerves, to obtain leave for the performance of interscapulo-thoracic amputation. The first step in the operation should now be division and sufficient removal of the clavicle, so as to clear up the state of the above important structures. If they are involved by the growth the major operation (p. 221) should be at once resorted to.

† In a case of this kind, Mr. Berkeley Hill transfused twice, but unsuccessfully, the patient dying of shock and acute septicæmia in forty-five hours (*Brit. Med. Journ.*, 1880, vol. i. p. 487).

be unduly anxious, is essential. (5) Taking care not to cut into the growth itself. (6) By some it is recommended to make the incisions gradually, not larger than are required at the time, as a means of minimising the hæmorrhage. It must be remembered, with regard to this point, that small and cramped incisions interfere with a free and rapid hand and sufficient exposure of the parts, conditions which conduce to thorough dealing with bleeding points, and thus facing one of the chief difficulties of this important operation.

Adequate drainage is now provided on account of the liability to subsequent oozing, the attachments of the trapezius and deltoid sutured together with fine sterilised silk, the flaps united, and the arm secured to the side for a few days, after which it may be supported in a sling if the head of the humerus does not tend to protrude.

In the case of sarcomata, removal of the scapula alone or together with the upper extremity (chap. viii.) may be called for.

The malignancy of these growths is well known, together with their tendency to involve surrounding parts and to creep into regions inaccessible to the surgeon. Early operation is imperatively required.

In the case of operation, the prognosis will be best, however large the growth, when the rate of progress has been slow, when the growth is uniformly hard, or if only a certain amount of elasticity is combined with the hardness (as in unmixed enchondromata) when the outline is distinct and well defined, and the mass movable upon the ribs.*

On the other hand, the prognosis is less favourable when the outline is uniform rather than nodulated or bossed, the feel semi-elastic instead of hard, the progress rapid and painful, the different parts of the scapula much obscured† and its mobility much impaired, the outline of the growth ill defined and lost indistinctly in the axilla. Pulsation, bruit, enlarged glands, infiltration of the skin, and any local rise in temperature are also of evil omen. In these cases when the prognosis is unfavourable the surgeon will do well to resort to interscapulo-thoracic amputation (p. 221).

* That this mobility is a matter of some importance is shown by the following case, quoted by M. Sédillot at p. 550 of his *Traité de Médecine opératoire*: "Nous refusâmes un jour d'opérer un jeune homme atteint d'un cancer énorme du scapulum, dont les limites n'étaient pas nettement fixées, et nous dûmes nous applaudir de notre abstention en découvrant plus tard, à la nécropsie, que la tumeur avait pénétré dans la poitrine et envahi un lobe pulmonaire." Mr. A. Marmaduke Sheild has kindly drawn my attention to an important case which shows how easily a sarcoma of the venter scapulæ may implicate the thorax, without any exact diagnosis of the position and extent of the growth being possible. A boy, æt. 10, was admitted under his care with a swelling, the size of an orange, on the axillary border of one scapula. This swelling was somewhat fixed, moving but slightly when the arm and scapula were raised at the operation. The intercostals and pleura were found to be blended with the growth. In the attempts to separate them the pleural sac was opened. Pneumothorax ensued, and death took place the next day. The specimen which illustrates this instructive case will be found in the Hunterian collection, R.C.S., No. 586b.

† In a very large scapular sarcoma on which Mr. Pollock operated, it is stated that "the mass extended over the upper portion of the scapula, which could not here be traced, and over the outer part of the clavicle, which could not be felt; and also so far into the lower triangle of the neck that the subclavian artery could not be distinguished or reached by the finger." The whole mass was removed, but the patient, aged 47, died on the sixth day, of chronic bronchitis.

CONDITION OF THE LIMB AFTER REMOVAL OF THE SCAPULA.—A limb thus preserved will be strong and useful. If the clavicle has not been much interfered with, the clavicular fibres of the deltoid will remain, and these, especially if sutured to the trapezius, together with the latissimus dorsi and pectoralis major, will probably confer a fair amount of motion on the limb. In one of Prof. Syme's cases, after removal of the scapula and the outer third of the clavicle, and, by a previous operation, the head of the humerus, the patient was able to lift heavy weights, and to fill the appointment of provincial letter-carrier.

In a very successful case of Mr. Symonds' (*Clin. Soc. Trans.*, vol. xx. p. 24), in which the scapula was removed for osteo-sarcoma, the man was in good health two years and a half after the operation.

He was able to do all the lighter work of a carpenter, including the use of a plane. Overhead work he could not do. In this case the articular surface of the humerus had also been removed about a month later, as it was thought to be the cause of prolonged suppuration.

The following case is of interest from the extension of the sarcoma into one of the scapular muscles, the ill-defined outline and soft feel of the growth, its long duration, and yet the long period of relief which has followed:

In March, 1892, one of the nurses at the Canterbury Hospital was sent to me by Dr. Alexander, of Faversham. The outline of the left scapula was replaced by a large mass, of uniform outline, fairly defined over the lower two-thirds of the bone, but above very indistinct, semi-elastic to the feel, without any nodules or bosses of harder growth. The scapula was movable upon the ribs. The history was one of early pain eight months before, for which the patient used to resort to the baneful remedy of rubbing her scapular region against any hard projecting ridge, *e.g.*, a mantelpiece. For the last three months the increase in the size of the swelling and in the pain had, alike, been rapid. The scapula was removed in Bright Ward, Guy's Hospital, and I am particularly indebted to Dr. H. Hodgson for the masterly way in which he administered the ether. The most interesting point about the case was that the sarcoma, which appeared to have begun in the infrapinnous fossa, had perforated the bone, and in many places greyish masses of growth could be seen blending with and replacing the delicate fasciculi of the subscapularis. The chief difficulty met with in the after-treatment was keeping the patient, a highly neurotic woman, and one not amenable to treatment, quiet. The wound did not run an aseptic course. Ten days later, incisions were required for drainage of the suppuration which followed. Later on, the articular surface and epiphyses of the head and tuberosities of the humerus became detached. Two years after the operation I saw the patient. The antero-posterior movements of the shoulder-joint were good. The patient could nurse a delicate mother, use her needle, &c., but abduction and elevation were almost completely abolished. In spite of the infiltration of one at least of the muscles, there was no evidence whatever of any recurrence.

Age of the Patient.—The scapula has been successfully removed for growth at ages varying between "about seventy" and "about eight." The former was a patient of Prof. Syme, who died about two months after the operation, apparently of internal deposits. The latter case occurred in India,* the upper extremity being removed at the same time.

* A very brief mention of this case is given in a letter, *Lancet*, 1874, vol. i. p. 819. It is not stated whether the patient was a native or no.

Dangers of the Operation and Causes of Death.—These will be the same as those given at the end of the next chapter.

2. Removal of the Scapula for Caries.*—This needs no especial mention. The parts being sufficiently exposed, the operation will be conducted, as far as possible, subperiosteally, by means of appropriate blunt dissectors or periosteal elevators.

* A good case of this kind is recorded by Sir W. Fergusson (*Med.-Chir. Trans.*, vol. xxxi. p. 310). An exquisite drawing of the scapula—one of the very best by the hands of the Baggs—will be found in the same author's *Practical Surgery*, 4th ed. p. 309, Fig. 144.

CHAPTER VIII.

REMOVAL OF THE UPPER EXTREMITY, ARM, SCAPULA, AND GREATER PART OF THE CLAVICLE.

INTERSCAPULO-THORACIC AMPUTATION.

THIS operation, performed chiefly for growths of the humerus which cannot be completely removed by amputation at the shoulder-joint,* occasionally for growths of the scapula (p. 218) and those of the axilla, as in Mr. Stanley Boyd's case (p. 225), and, much more rarely, for injury, persistent carcinoma of the breast and tubercular disease,† has been of late years advocated by M. Paul Berger (*L'Amputation du Membre supérieur dans la contiguïté du Tronc*, Paris, 1887) amongst Continental surgeons, and by Sir F. Treves and others in this country and America.

The method described below is that of M. Berger; a very clear account is also given by M. Farabeuf (*loc. supra cit.*), and one by Sir F. Treves (*Oper. Surgery*, 2nd ed. vol. i. p. 380): on these I have drawn largely.

First Step.—Division of the clavicle and securing the vessels. The patient being brought to the edge of the table, with his shoulders raised, the surgeon, standing outside the limb, makes an incision with a stout scalpel along the whole length of the clavicle, from just outside the sterno-mastoid muscle to a point immediately beyond the acromio-clavicular joint. The incision divides the periosteum down to the

* As in Mr. Barling's case (*Brit. Med. Journ.*, vol. i. 1898, p. 883), any surgeon in doubt as to the necessity of submitting his patient to so severe an operation, should begin by an incision between the deltoid and pectoralis major, and then, when the muscles are thoroughly retracted, examine the condition of the axilla, the glands, and determine whether the large vessels and nerves are imbedded in the growth, &c. In other cases, division and partial removal of the clavicle may be required in order to clear up the doubtful point. In every case this preliminary incision should be made at the time when the operation is to be completed, and not as a preliminary step. Dr. A. Cobb, of Boston (*Ann. of Surg.*, Feb., 1905, p. 267), relates a case of interscapulo-thoracic amputation which emphasises this point. The case was one of giant-cell sarcoma of periosteal origin of the humerus of only eight weeks' duration. A diagnostic incision being insisted on by the patient, this step showed that the deltoid was infiltrated. Very sharp reaction followed, and, eight days later, when the major operation was performed, sarcomatous thrombi were found in the subscapular vein. The possibility of these having been dislodged at the preliminary operation is allowed. This paper is illustrated by two good skiagraphs.

† In cases of injury which appear to call for so severe an operation, it will always be doubtful if the patient will survive so severe a step. In the two conditions last mentioned this operation can very rarely be justified. In cases of carcinoma of the breast it is considered in the account of this subject, *q. v.*

bone over the middle portion of the clavicle. At this stage venous oozing from the large superficial veins here met with may be very free. With a curved elevator (Fig. 66) the periosteum is separated from the middle portion of the clavicle.* A large blunt hook (Treves) or a blunt dissector being passed under the inner end of the bared part of the clavicle, this is sawn through with a narrow or Gigli's saw. The same part of the clavicle being now raised and steadied with lion-forceps, and the periosteum completely separated from its under surface, the bone is again divided at the outer end of its middle third. If resection of part of the clavicle is performed, the removal of bone must be free enough to facilitate the finding of the subclavian vessels. Limited removal of bone will much increase the difficulties of the above step (pp. 223 and 225). The tendency of the upper extremity to fall outwards after division of the clavicle will increase the space between the two parts of this bone. The exposed subclavius with its sheath is now isolated and cut through close to the site of the inner section of the clavicle, dissected up so as to expose the large vessels, and turned outwards.† Fasciæ of varying thickness will have to be divided before the vessels are reached (Treves). During this step the great pectoral should be freely divided especially in muscular subjects, and the upper border of the pectoralis minor should, if possible, be defined; the surgeon must be prepared for troublesome bleeding from the cephalic vein and branches of the acromio-thoracic vessels, and he may find a guide recommended by Berger—viz., the external anterior thoracic nerve—easy to see or feel. This nerve, if followed upwards, leads to the interval between the artery and vein.‡ These large vessels are then secured and divided between double ligatures of carefully sterilised silk, pushed well apart in each case, and tied very securely before each vessel is cut. The ligatures should be placed upon the subclavian vessels themselves, at a point to which the tubercle on the first rib will be a guide. If possible the artery should be secured first, and the arm well raised while the ligatures are placed around the vein, so that as little blood as possible be left in the extremity. Tying the artery first will lessen the size of the vein and render the securing of it less difficult; furthermore, as pointed out by Prof. Keen, if the vein be injured, as happened in his case, while it is being tied, the wound will not be flooded with blood. If, however, the vein be so much distended as to obscure the artery, the former vessel must be taken first. In either case the greatest care must be exercised not to injure this vessel for fear of air entering the circulation. If any such accident occur, the spot must be instantly closed, and the wound flooded with sterile saline solution or some weak aseptic lotion. While exposing the vessels, the supra-scapular vessels will probably be seen crossing the

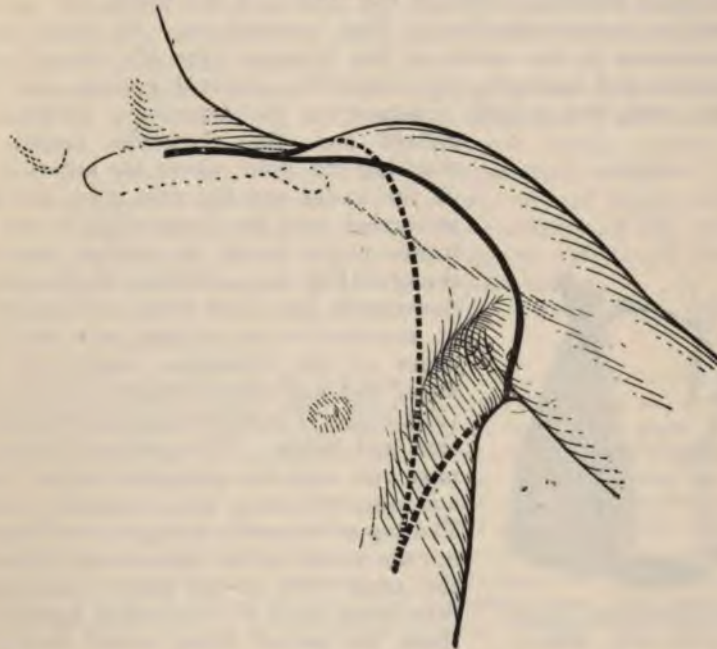
* This preliminary detachment of the periosteum was recommended by Prof. Ollier as a safeguard against wounding the vessels. Mr. Chavasse (*loc. infra cit.*) says that "practically this step is not to be recommended, as the periosteum left obscures the subclavius muscle, and has to be immediately divided." I should further object to it, in cases where the operation is performed for the removal of malignant disease, as likely to favour recurrence of the growth.

† The subclavius must be thoroughly divided in order to obtain room for securing the vein.

‡ Careful feeling for the pulsation of the artery will be another aid.

upper part of the wound, and should be secured. The nerve-cords should be cut square and as high up as possible. Before they are severed each should be injected with eucaïne (p. 226). Mr. Stanley Boyd, in his case (*infra*, p. 225), finding that removal of the middle third of the clavicle was insufficient to permit of easy ligature of the vein, which lay beneath the inner third, removed another inch from the bone. He also found that division of most of the brachial plexus facilitated

FIG. 104.



Interscapulo-thoracic amputation. Outline of the flaps (left side). The posterior or cervico-scapular flap is shown dotted. (Farabeuf.)

ligature of the artery, the plexus at once starting into relief on division of the clavicle.

Dr. Le Conte, of Philadelphia (*Annals of Surgery*, Sept. 1899), recommends disarticulation of the sternal end of the clavicle as preferable to resection. In the latter the large vessels are exposed in a narrow field and at a considerable depth. Disarticulation he believes to be simpler, quicker, and safer, by its giving a much fuller exposure of the vessels.* The incision is begun over the sternal end of the clavicle, carried to about its middle, and then curved downwards to the anterior axillary fold. The skin and superficial fascia are dissected up, exposing well the inner two-thirds of the clavicle. This bone is then

In addition to the cases I have mentioned in the footnote, p. 225, in all of which much difficulty was met with in securing the large vessels, Dr. Le Conte mentions three others in which the same trouble occurred. The operators were von Langenbeck (*Arch.f. klin. Chir.*, 1862, Bd iii. s. 340) and (Ollier *Lyon Medical*, Feb. 1885, t. xviii. p. 158)

disarticulated by severing its attachments to the sternum and rhomboid ligament, the clavicular part of the sterno-mastoid and pectoralis major. The clavicle is now pulled upwards and outwards, and the subclavius stripped off or divided. The pectoralis minor is now seen and divided, and the vessels thus well exposed.*

Second Stage.—Formation of the flaps. These are pectoro-axillary and cervico-scapular, and, in fashioning them, the surgeon must be guided by the extent of the disease. The patient being so placed and steadied that the whole of the scapular region is free of the table, and the surgeon standing between the limb and the trunk, the pectoro-axillary flap is then traced as in Figs. 104 and 105. As there shown, it commences in the centre of the incision over the clavicle, runs downwards and outwards just above the coracoid process, and then parallel with, but a little external to, the depression between the

Fig. 105.



Interscapulo-thoracic amputation (right side). (Keen.)

deltoid and the pectoralis major. On reaching the point where the anterior wall of the axilla and the arm join, the knife is carried over the lower edge of the pectoralis major across the axillary aspect of the arm (Fig. 104), and then backwards and downwards (the limb being well raised by an assistant) so as to pass over the lower edges of the latissimus dorsi and teres major and end over the apex of the scapula (Fig. 105). The above incision only divides skin and fasciæ. The pectoralis major is next cut, and the pectoralis minor found and severed near the coracoid process. The top of the axilla being now well opened up, the cords of the plexus are divided at the same level as the large vessels, great care being taken of the central ligatures on these, the patient being rolled over on to his sound side, and the limb drawn across the chest. The cervico-dorsal flap is next made by drawing the knife from the outer extremity of the clavicular incision, straight back over the spine of the scapula to the lower angle of this bone, where it meets the first incision. The skin and fascia divided by this incision are reflected to the vertebral border of the scapula.†

Nothing now remains but the *third and last stage*—viz., the removal

* Dr. Le Conte also points out that complete removal of the bone is safer in cases of growth than leaving the sternal end. This step would also be indicated when there are great difficulties in finding the subclavian artery where the clavicle itself is involved. With regard to this last point, Dr. A. Cobb (*loc. supra cit.*) gives the warning "that where malignant disease has so extensively involved the tissues at the base of the neck and the substance of the clavicle as to require excision of the whole clavicle, it may be questioned whether any operation is advisable." He advises against removal of the whole bone as unnecessary, and as involving additional risks, *e.g.*, wound of the innominate vein or pleura.

† In a case of cystic lympho-sarcoma, in which the growth covered the shoulder and extensively involved the skin of the posterior triangle, Mr. Spencer (*Clin. Soc. Trans.*, vol. xxviii, p. 165) was obliged to take skin from the arm.

of the limb. This is effected by the division of the trapezius, omohyoid, latissimus dorsi, levator anguli, rhomboids, and serratus magnus. While these muscles are severed the flaps are well held back, and the limb suitably manipulated, partly by an assistant and partly by the left hand of the operator.* During this stage the posterior scapular and the supra-scapular may or may not require ligatures, according as they spring from the first or the third part of the subclavian, in the latter case being on the distal side of the ligature (Spencer). But of course the mere mention of normal arteries gives no idea of the number of both veins and arteries that will be met with, enlarged, in cases of new growths. This makes it all the more important to secure first the subclavian artery and vein.

The flaps and all the recesses of the large wound are most carefully scrutinised for any evidence of infiltration or extension of new growth. The muscles, especially the pectorals (Stanley Boyd), should be cut short to avoid any possibility of infiltration. Where it is thought advisable to shorten the nerve cords, each of these should again be injected with eucaine (p. 226). The condition of the glands in the posterior triangle should also be investigated. Drainage should always be employed on account of the subsequent oozing.

Mr. Stanley Boyd (*Brit. Med. Journ.*, vol. i. 1898, p. 883), related the following instructive case.

Five weeks previously a man, æt. 25, had come under his care at the Charing Cross Hospital for sarcoma of the axilla, which had attained the size of two fists in three months. It was not fixed to bone, but was closely attached to some soft parts. There was no evidence of pressure on the great vessels or nerves, of involvement of the supra-clavicular glands, or of secondary growths in the viscera, &c. Operation proved that the great vessels and nerves were so surrounded by growth that only an interscapulo-thoracic amputation would remove the disease. As consent had not been obtained, nothing further was done then. Four weeks later the mass round the vessels had increased considerably, and amputation was performed on Berger's lines, with certain improvements in two or three details, which have been mentioned above. The patient, at the time of the report, was making an excellent recovery.

Dangers of the Operation and Causes of Death.—These are :

1. Hæmorrhage.†—This may be met with from the main trunk, the

* The humerus, if much invaded by growth, may, here, give way.

† Control of this is the key to the situation. The following cases show what difficulties may be met with in meeting it. Mr. Macnamara (*Lancet*, vol. i. 1878, p. 669), after resecting part of the clavicle, was unable to find the artery owing to the large veins exposed. The hæmorrhage was very great, and the patient died on the following day. A portion of growth was found to have passed upwards behind the scaleni muscles. Mr. Chavasse, in his case (*Med.-Chir. Trans.*, vol. lxxiii. p. 81), being unable, owing to free venous oozing, to tie the subclavian vessels, divided the first part of the axillary vessels between double ligatures. Profuse arterial hæmorrhage followed, on the seventeenth day, from the lower part of the wound, which was granulating (it is not stated whether the healing had been aseptic throughout). The second part of the subclavian artery was tied, and the patient made an excellent recovery. Prof. Keen (*Amer. Journ. Med. Sci.*, June, 1894) met with great trouble in securing the subclavian vein. "A large vein under the inner sawn end of the clavicle tore, and gave me much trouble, but finally, partly by a ligature round the tissues in which lay the vein, and partly by a ligature which was applied temporarily round the tissues and round the sawn end of the clavicle, sawed in the bone, so as to prevent the slipping of the ligature, I was able to secure it." Another most instructive case is given by Prof. Keen, *Annals of Surg.*

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scapular branches of the subclavian, the branches of the axillary, and the enlarged anastomosing veins in cases of growth. The first two of these dangers, and the third, to a larger extent, will be met by tying the subclavian vessels after Berger's method. This also prevents entrance of air into the large veins, allows of section of vascular muscles like the great pectoral with scarcely any bleeding, while division of the posterior muscles, where the arterial supply has not been cut off, is reserved for the last step of the operation. If, after resection of the clavicle, it is found impossible to secure the third part of the subclavian vessels owing to the profuse venous oozing, or to the displacement of the parts from invasion by the growth, Mr. Chavasse advises proceeding at once to make the upper part of the anterior flap, dividing the two pectoral muscles, and, after fully exposing the first part of the axillary vessels, tracing these up to the scalenus anticus and tying the subclavian artery and vein. Other courses open are to tie the subclavian vessels in their third part in the usual way. Dr. Joseph Bell (*Man. of Surg. Operations*, sixth ed.) provided for the hæmorrhage by a "skewer" passed under the clavicle and vessels, and a rubber cord looped round.

2. Shock.—This will be met by taking every step to prevent shock and hæmorrhage, bandaging the limbs and abdomen, keeping the body warm on a hot-water table, administering ether, emptying the limb of venous blood before the vein is tied, and completing the operation as speedily as possible. Afterwards, infusion of saline fluid (p. 141) should be resorted to, if other methods—*e.g.*, subcutaneous injection of strychnine, ether or brandy, enemata of port wine and beef-tea, and bandaging of the other limbs—are insufficient.

This will be a fitting place to refer to an important point raised by Harvey Cushing (*Ann. Surg.*, Sept. 1902) in the avoidance of shock in major amputations by cocainisation of large nerve-trunks preliminary to their division as first advised by Crile (*Problems relating to Surgical Operations*, Philadelphia, 1891). "The term 'shock' represents a peculiar state of depression of the central nervous system. Such a condition is usually brought about by injury of one sort or another to peripheral afferent nerves, the impulses from the injury having acted reflexly upon the vaso-motor mechanism in the medulla, so as to cause a marked fall in the blood-pressure.

While shock may be diminished by perfect hæmostasis, and preventing chills, in cases where shock is already present before operation, the possibility of prolonged anæsthesia and some further loss of blood render it certain that a further especial risk is attendant upon the division of important sensory nerve-trunks. As cocaine injected into a nerve-trunk effectually blocks the transmission of all centripetal or sensory impulses, cocainisation of main nerve-trunks central to the proposed site of their division in a major amputation prevents the conduction of those impulses resulting from this further injury, which otherwise, by acting reflexly through the medullary centre, might become further factors in the production of shock."

In illustration of the above principle, Cushing relates two cases of interscapulo-thoracic amputation, one of which was done without, the other with cocainisation of the chief nerve-trunks. In both hæmostasis was complete, and, except for the above difference in operative technique, the cases were in every respect similar. Two charts recording the

pulse-rate are given, showing distinctly that in the case in which the nerve-trunks were divided without cocainisation there was marked evidence of shock, which was absent in the case where cocaine was employed.

Lund (*Boston Med. and Surg. Journ.*, Apr. 16, 1903) relates a case of the above operation for sarcoma of the brachial plexus, probably dating to an injury and originating in the median nerve, in which each cord of the brachial plexus was injected with ten minims of a 0.25 per cent. solution of cocaine before division. The pulse was unaffected.

In Dr. F. Cobb's case (p. 221) the same precaution was taken, with the result that there was no shock whatever from this operation; the pulse remained at 80 throughout, and did not change in volume at any time.

3. Septicæmia.—This is a very probable danger, if the flaps (perhaps left needlessly full) slough, or if retention and bagging of discharges are allowed to occur in the large cavity which will be present in the stump, unless this is obliterated by pressure, or sufficient drainage employed.

4. Entrance of air into veins.—This very nearly proved fatal in a case in which Mr. Jessop, some years ago, removed the scapula, outer half of the clavicle, and the upper extremity (*Brit. Med. Journ.*, vol. i. 1874, p. 12).

In this case the scapula seems to have been removed owing "to considerable deficiency of cover" after removal of an upper limb much damaged by a machinery accident. "Whilst cutting through the last attachments of the scapula, two distinct loud whiffs were heard, caused by the rush of air into the subclavian vein." The operation was completed while artificial respiration* was being performed, and the lad recovered.

5. Recurrence.—While the results of this severe operation are, as far as immediate recovery goes, good, recurrence, in the case of periosteal sarcomata, takes place, as a rule, within six or twelve months. Sir F. Treves (*Oper. Surg.*, 2nd ed., vol. i. p. 381) writes on this point: "Although interscapulo-thoracic amputation is probably the best measure in all cases of sarcoma (ossifying or not) of the upper part of the humerus, the prognosis is very gloomy. In at least 75 per cent. fatal occurrence has followed within a year." The statistics collected for M. Berger (v. *infra*) show that the prognosis is better in cases of sarcoma of the humerus, than in those where the growth affects the scapula or the soft parts, and that it is best of all in chondromata.

6. If the patient survive, an artificial limb should be fitted at an early date. It may not admit of active usefulness, but it will be of service in preventing the feeling of most irksome lopsidedness which in the convalescence and early getting about causes these patients so much discomfort in balancing themselves.

7. With regard to the *mortality* of the operation, the most recent statistics are those collected by MM. Jeanbrau and Riche for M. Berger, and brought by him before the Society of Surgery of Paris (*Bull. et Mém.*, May 16, 1905, p. 435). It will be seen that it varies widely according to the origin of the growth. In cases of *growth of the humerus* the mortality is stated to have been 2.75 per cent.; in *growth of the scapula* 23.80 per cent.; and in *growths of less certain origin, e.g., soft parts, glands, &c.*, 11.76 per cent.

* Unless the wound is kept flooded, this step is not without the risk of drawing in more air.

CHAPTER IX.

OPERATIONS ON THE CLAVICLE.

REMOVAL OF THE CLAVICLE.

REMOVAL may be occasionally required for new growths or necrosis. In either case it is but rarely called for. That for necrosis differs in no way, save for the importance of surrounding parts, from the same operation elsewhere.

Removal of the Entire Clavicle for New Growths.—The following are the chief points to bear in mind, viz., that—(1) The degree of malignancy of sarcomata of bone varies here, as elsewhere, within very wide limits (p. 92). (2) That slowness of growth, a well-defined outline, regularity of expansion (p. 92), together with absence of swelling of the hand, will be favourable evidence. (3) A free incision is needed along the curves of the bone, with any additional one that is required. (4) Plenty of Spencer Wells's forceps must be at hand. (5) The acromial end should be set free first, either by opening the joint or by sawing the bone, if healthy. (6) The freeing of the coraco- and costo-clavicular ligaments is often a matter of much difficulty owing to their depth and the way in which the bone may be tied down by the growth. (7) With periosteal sarcomata of any duration, outlying processes may be present. (8) If this be the case towards the inner end of the growth, it will require the greatest caution to avoid opening up connective tissue which is continuous with that of the mediastina. (9) Division of the clavicle—a step sometimes taken to facilitate its removal—should be avoided, if possible, as the wound may thus become infected with growth. (10) As in all removal of bones infiltrated with growth, the clavicle may fracture during operation; the outer end should then be seized with lion-forceps and dissected out so as to give more room for dealing with the sternal extremity. The account which follows, by Mr. Bowreman Jessett (*Lancet*, vol. i. 1889, p. 1077), of a case in which he removed the entire clavicle for a large subperiosteal sarcoma, shows well the sort of operation required, and the difficulties likely to be encountered:

The patient was a girl, aged 16; the growth was of more than a year's duration, and extended over the inner two-thirds of the clavicle. The following were the most important points which led the surgeon to recommend operation: The age of the patient. The fact that the growth (as shown in an illustration which accompanies the paper) extended much farther on to the chest wall than it did into the neck. It had originated on the front of the clavicle, and had only quite lately caused any pressure on the vessels. The skin was not implicated; while complete removal was doubtful and attended with much risk, if left, the growth must inevitably have been fatal and, from pressure on the large nerves, attended with great pain.

A $\neg$ -shaped incision was made, the long limb along the clavicle and the shorter one over the sterno-clavicular joint and growth. Flaps being reflected, the muscles were detached from the bone as far as possible, and the outer fibres of the sterno-mastoid divided on a director. A metal spatula was next passed behind the bone at the junction of the outer and middle thirds, and the bone divided here with a narrow saw, the section being completed with bone-forceps. The inner fragment was then pulled forwards with lion-forceps, while the subclavius was carefully detached with scissors curved on the flat. Some difficulty was met with in opening the sterno-clavicular joint, as this was overlapped by the growth.* A further extension of this over the top of the first rib made it difficult to divide the costo-clavicular ligament, which was effected with scissors after suitable dragging up and rotation of the fragment and growth. Care was taken to leave untouched the sternal head of the sterno-mastoid. The anterior and external jugular veins were divided between double ligatures. The outer part of the clavicle was then seized with lion-forceps, and removed (a small portion of the periosteum at the extreme end being left) after division of the muscular and ligamentous attachments. There was very little loss of blood. The patient made a good recovery, and three months later "the movements were equally good with those of the opposite side." In 1893, speaking at a meeting of the Medical Society, Mr. Jessett said that several small recurrent growths had been removed.

In Prof. Mott's case (*Amer. Journ. Med. Sci.*, O.S., vol. iii. p. 100) the subclavius could not be seen, being incorporated with the diseased mass. This greatly increased the difficulty of keeping above the subclavian vein. This vein was firmly adherent to the growth, but was finally detached by the most cautious use of the handle and blade of the knife alternately. The patient lost from 16 to 20 ozs. of blood, but made a good recovery. The growth was an "osteosarcoma," the size of two adult fists. The necropsy, fifty-four years later (the patient's death not being connected with the growth), showed that $\frac{3}{4}$ inch of the acromial end had been left, the rest of the site of the bone being occupied by a ligamentous band. And the latter, no doubt, is the condition present in the other cases where the after use of the limb has been so good. The use of the arm is said to have been complete. In Mr. Travers's case, where three-fourths of the clavicle were removed, there was scarcely any restriction of the movements of the arm, one of the boy's amusements having been rowing on the Thames. Again, in a case in which the whole clavicle, save a small portion of the acromial end, was removed for a malignant growth, the man afterwards found no hindrance from the loss, being able to act as a bricklayer's labourer and miner.

Mr. Haslam brought a case before the Medical Society (*Lancet*, vol. i. 1893, p. 930) in which he had completely removed the clavicle five months before. The growth was a periosteal sarcoma, and examination showed that its amount was small in proportion to the new bone formation. Some cartilage was also present.

Dr. Vaughan (*Med. News*, Jan. 8, 1898) performed complete excision for a mixed-cell sarcoma. Twelve months later the man was in good health, and had been carrying on his work as fireman on a steamboat. Here it was thought that suture of the detached sterno-mastoid and trapezius to corresponding points in the pectoralis and deltoid had contributed to the excellent functional result.

In February, 1899, I saw my colleague, Mr. Symonds, remove the clavicle for a mixed-cell sarcoma. The outline of the bone was here masked by the growth, and the boundaries of the latter not well defined. The operation was rendered difficult throughout by the very free bleeding at all points, the extent to which the bone was tied down, and the consequent difficulty of getting at the coraco-clavicular and costo-clavicular ligaments. The patient made a rapid recovery, and remained well a year later.

A case of angeio-sarcoma of the clavicle is recorded by Dr. Beatson, of Glasgow (*Brit. Med. Journ.*, vol. i. 1902, p. 128). The drawing

* In a case of Mr. Caddy's, of Calcutta (*Med. Rec.*, Nov. 19, 1892), in which the inner two-thirds of the right clavicle were removed for a periosteal sarcoma, the pleura and innominate vessels were exposed in dissecting away a tongue of growth which passed down behind the manubrium. The patient recovered with perfect movement of the arm.

accompanying the paper shows the usual globular swelling, and gives as good an idea of the fixity which may be met with as it is possible for an illustration to do. The second rib where eroded by the growth required gouging, and some enlarged glands, the nature of which is not given, were removed from the posterior triangle, and six months later a further removal of glands was performed which the microscope left undecided whether they were sarcomatous or inflammatory. Yet the patient was alive and well two years after the first operation.

A good instance of *partial* removal of the clavicle is recorded by Mr. Bland Sutton (*Clin. Soc. Trans.*, vol. xxiv. p. 12):

Here the acromial half was removed for a myeloid growth in a woman, aged 26. The chief difficulties met with were, first, the tightness with which the bony capsule was tied down over the coracoid process by the coraco-clavicular ligaments, these structures requiring careful division with scissors. Secondly, the supra-scapular nerve ran in a shallow groove in the capsule of the tumour, and was reflected without injury. Nearly four years later there was no evidence of recurrence. A fibrous band united the remains of the clavicle and the acromion, and the patient could perform all movements of the extremity perfectly.

OCCASIONAL CONDITIONS OF THE CLAVICLE, ACROMION, OR THEIR JOINTS WHICH MAY CALL FOR OPERATION.

A. Fractures of the Clavicle.—Operative interference may, very rarely, be called for in some of the following cases: (1) In recent cases with very marked displacement difficult to reduce or keep in position, as in fracture of the acromial end, outside the coraco-clavicular ligaments. (2) In compound and comminuted cases, after the wound has been enlarged so as to promote asepsis, wiring of the fragments will be quite justifiable, especially if they are comminuted. (3) In cases where, owing to excessive callus or pseudarthrosis, there is pressure on the nerves or vessels. (4) Where an ugly union or pointed process of bone presses on the skin or causes disfigurement.

An excellent instance of pseudarthrosis* in which pressure on the nerves supervened later, most successfully treated, has been recorded by Mr. Barker (*Clin. Soc. Trans.*, vol. xix. p. 104):

A boy, aged 12, was noticed soon after birth to have a fracture of the right clavicle, the cause of this being uncertain. Up to nine years of age the child had no inconvenience. He was then gradually more and more troubled with pressure on the brachial plexus, pain down the arm, and a tendency of the fingers to become stiff and fixed in a flexed position in writing, this condition soon amounting to one of painful spasm, rendering the writing quite illegible.

With a view of resecting the false joint, lifting the inner end of the outer fragment off the brachial plexus, and wiring it to the inner fragment, Mr. Barker operated as follows:

"Observing all the details of the Listerian method of antisepsis, I made a semilunar incision, about 3 inches long, with its two ends on the clavicle, and its convexity downwards. This corresponded to the middle of the bone, having the false joint above its

* As a rule, non-union or pseudarthrosis of the clavicle does not cause the patient much trouble, if it has occurred in early life. Though the ends of the bone may be atrophied, calluses will be found hypertrophied.

acromio-clavicular dislocation. In each case the lesion was of several years' standing, and the usefulness of the limb much impaired. In all three the result was excellent.

I have operated by resection and wiring in three cases of acromio-clavicular dislocation, two of these being primary and one a secondary operation. In two the result was perfect. In the third, one of the primary cases, infection followed, and the wire had to be removed. The deformity was, however, removed, and the union was secure. The infection was due to my omitting to use drainage. The patient, a middle-aged bulky man, had fallen heavily when drunk. There was much deep extravasation of blood extending between the coraco-clavicular ligaments. This fact, and the probability of the thick, dirty skin being imperfectly cleansed ought to have called for drainage.

C. Disease of the Joints.—It is well known how obstinately tubercular disease sometimes settles on the sterno-clavicular joint. The simplicity and the superficial position of this joint render erosion, followed, if need be, by removal with a chisel or osteotome of one or both bone-ends, a most successful operation, as I have found in two cases.

CHAPTER X.

SKIN-GRAFTING BY THIERSCH'S AND OTHER METHODS.*

THIERSCH'S method, promoting as it does rapid and sound healing with a minimum of contraction, is often called for where large open surfaces are left to heal—*e.g.*, after burns, removal of a cancerous bosom on wide lines, ulcers of the leg, extensive lupus, and the like. The following steps must be carefully considered:—

i. **Preparation of the patient and surface to be grafted.** The patient must be in satisfactory condition, and one who can be relied upon to keep absolutely still. The surface must be either a recently-made wound, or, if an ulcer of any kind, one in which healing has begun. But, above all, it must be aseptic. If the surface be foul, there is nothing better than curetting once or twice with the aid of eucaïne if needful, boracic acid fomentations and the occasional application of pure carbolic acid. The adjacent skin must be shaved over a sufficient area after thorough soaping, then cleansed with turpentine, and again carefully purified with soap and a nail-brush. In two or three days' time, when the ulcer shows the usual evidence of healing, one of the usual aseptic dressings is applied, *viz.*, iodoform gauze wrung out of carbolic acid lotion (1 in 30), and green protective, or cyanide gauze out of a sublimate solution (1 in 4000). Either gauze is bandaged on with salicylic wool. The shaving should be repeated every four days.

ii. **Preparation of the area from which the grafts are to be taken.** Thirty-six hours before the operation the skin of this area is to be carefully disinfected in a manner similar to that already detailed, especial care being given to such regions as the axilla, and an aseptic dressing must be worn up to the time of the operation: œdematous granulations will require further curetting.

iii. **The actual grafting.** The anæsthetic having been given, and the surface to be grafted exposed, the superficial layer of granulation tissue is to be removed together with the edge of the ulcer, whether healing or no. Every atom of the watery layer of granulations should

* I have dealt with this subject here, as I prefer to take Thiersch's grafts from the skin of the shoulder, arm, and forearm. Others—*viz.*, Messrs. Watson Cheyne, C.B., and Burghard (*Surg. Treat.*, pt. i. p. 50) [the account given by these writers is most practical and helpful; I have taken many hints from it], and Duplay and Reclus (*Traité de Chir.*, t. i. p. 278)—recommend the front of the thigh. I prefer the first region, as possessing more vascular and more easily sterilised (because less hairy) skin. It further presents obvious advantages in extensive cases, *e.g.*, burns, the grafts in from both regions.

be removed with a sharp spoon. The next step is to arrest the free oozing which follows. This is effected by firm pressure, applied by means of sterilised green protective* and salicylic wool firmly bandaged on. The surface from which the grafts are to be taken is now exposed and again cleansed. The operator, with his hand placed under the limb, stretches the skin from side to side, while assistants keep it on the stretch above and below. With a broad and heavy razor (carefully sterilised) the grafts are now taken. The blade is placed at such an angle to the skin, that when it is entered and carried along it will remove a very thin shaving of the epidermis, filmy and greyish-white, falling at once into delicate folds as it is cut, and exposing, and only just exposing, the tops of the papillæ. It is then carried on with a lateral to and fro sawing movement. The skin must be kept carefully on the stretch all the time, and the razor must be wetted from time to time with a few drops of sterilised salt solution or boracic acid.† The grafts should be about two inches wide, and four or five inches long, and should consist only of the horny and the superficial part of the Malpighian layer, the tops of the papillæ being only just trenched upon.‡ Any tendency the grafts may show to curl up in front of the razor should be checked by an assistant carefully keeping the part cut on to the razor. When the cutting of each graft is finished, an assistant should set it free by one stroke of a pair of sharp scissors. If the bleeding on the area to be grafted has ceased, the grafts should be transferred directly on the razor or a microscopical section-shifter (Ballance), laid down each on their cut surface, and then gently and evenly flattened out with needles. If the bleeding has not ceased it will be preferable to follow the advice of Watson Cheyne and Burghard (*vide supra*), and to leave the grafts lying on the bleeding surface, this plan being more likely to retain the vitality of the grafts than that of putting them into a warm saturated solution of boracic acid. All layers of clot, oozing or other liquid, must be carefully removed from the surface to be grafted, with dossils of sterilised gauze. The writers just mentioned give the two following useful hints: "The grafts should overlap the edges of the skin, and also each other, so that no part of the raw surface is left exposed, for granulations always spring up on the uncovered parts; furthermore, a thin scar, which may subsequently break down, is left at these points. In spreading out the graft it will be found that air-bubbles collect beneath it, and also that some amount of oozing goes on, and the bubbles and clot may prevent complete adhesion of the graft. Hence, the next procedure is to get rid of them by pressure. If that be attempted by means of sponges in the hands, the graft is apt to be displaced. The following is the best plan: Strips of protective about an inch in breadth, and long enough to overlap the edges of the wound, purified in 1—20 carbolic lotion, and subsequently rinsed in boracic lotion, are applied firmly over the grafted surface,

* This must be used now; otherwise, gauze or sponges, when removed, would cling to the surface and start fresh bleeding.

† The usual powerful aseptic lotions may injure the vitality of the grafts, and, if the surfaces have been rendered aseptic, such lotions will no longer be needed.

‡ A test of the proper depth cut into by the razor is shown by the nature of the bleeding, and the rate at which this follows. It should be minutely punctiform, very slight, and slow in making its appearance,

beginning at the lower part. Each strip should overlap the one below, just as in the case of strapping, and they should extend well on to the skin at each end. If each strip as it is put on be grasped by the two ends and firmly pressed down, the pressure thus applied suffices both to expel the air-bubbles and blood, and also to arrest further capillary oozing." When the surface to be grafted is completely covered with grafts and strips of green protective, a dressing of iodoform or cyanide gauze and salicylic wool is applied, with firm, even pressure. If the surface be on a limb, this must be kept at rest on a splint. The surface from which the grafts were taken is next dressed in the same way as the ulcer, this dressing being left on for a week or ten days. The dressing on the grafted surface should be left undisturbed for five or more days, if possible. Its removal must be effected with much carefulness; gentle washing with dilute carbolic acid, sublimate, or lysol lotions, or careful syringing should be employed lest any of the grafts be peeled off with the protective. All is doing well if the grafts have a pink colour and are adherent. If white or greyish in tint they are no longer alive.

Where a surgeon is in doubt as to the asepticity of the area to be grafted, and where reasons are present for losing no time, I strongly advise the use of formalin. The parts having been thoroughly cleansed, for some hours before the grafting compresses of 1 or 2 per cent. solution of formalin are applied. At the time of the operation the granulations will be characteristically dry and hard, and must be removed with curved scissors rather than a curette. The bleeding is arrested and the grafting completed as advised above.

The *technique* of grafting on a fresh wound is in all essential points similar to the above.*

Wolfe's method. Here the whole thickness of the skin and subcutaneous fat is removed without any pedicle from the most vascular area attainable. While the percentage of failure is much greater than in Thiersch's method, cases occasionally present themselves in which a trial of this method is indicated, *e.g.*, when a thicker covering is required than is afforded by Thiersch's method, as in the palm of the hand. When this method is successful its results are most satisfactory. While part of such a flap may perish, enough may survive for the surgeon's purpose. Mr. Keetley, whose experience in plastic surgery and his ingeniousness in adopting its different methods are well known, thus describes Wolfe's method (*Lancet*, Mar. 4, 1905). When such a graft has been cut out, half a dozen Spencer Wells's forceps should be attached around its edges. "Place it, raw surface upwards, on a sterilised towel and a convex surface, usually the thighs or chest of the patient. Stretch the flap in every direction by pulling at the forceps. Shave off all the fat. Stretch the flap again to take the tendency to curl up out of it. Swing it into place. Secure it with a

* To take one particular instance. Anyone who has to face the difficulties presented by a case of avulsion of the scalp will find useful information in a paper by Dr. Mellish (*Ann. of Surg.*, 1904, p. 644). Owing chiefly to the difficulty of maintaining adequate even pressure of the dressings, without injurious pressure upon the subjacent Thiersch's grafts, the cure took about seventy days. The hint is given to preserve the hair, in the case of a woman, for a wig. Good photographs accompany the paper.

few sutures. But cut away all the forceps so as to leave no bruised skin behind, the most rigid asepsis being desirable to secure success." Mr. Kennedy, of Glasgow, discusses the relative value of the three methods, Reverdin's, Thiersch's, and Wolfe's (*Glasgow Hospital Reports*, vol. ii. 1900, p. 198), and gives cases in which such flaps taken from the extremities were used to fill up gaps left by the removal of cicatrices which had caused contraction of fingers into the palm. The same surgeon has published (*Brit. Med. Journ.*, April 29, 1905) some figures which show excellently what Wolfe's method may effect in like cases.

Reverdin's method. While undoubtedly inferior to that of Thiersch this method has still a place in surgery as in completing the healing of a large burn or lupus of the face. . Owing to its not needing an anæsthetic patients will in such cases gladly submit to it. A portion of skin being picked up with a needle, it is quickly removed with small, sharp, curved scissors. The use of the prepuce for grafting, theoretically so admirable in hospital practice, often fails owing to the prepuce not being secured sufficiently fresh, to its being incompletely sterilised, and to its tendency to curl up. If it be employed it should first be slit up, and then as completely sterilised as possible, and well stretched by the means described above. It is then cut into three or more portions, and where the surface to be grafted is large, these are taken by two operators and cut up into minute portions. As in all cases of Reverdin's grafting these should be placed thickly together so as to leave no room for granulations to spring up between the islets and destroy them, and this should be especially done round the edges, in the neighbourhood of the growing epithelium.

For some further information I will refer my readers to the section on the "Plastic Surgery of the Face," and to that on "Conservative Surgery of the Hand" (p. 20).

PART II.

THE HEAD AND NECK.

CHAPTER I.

OPERATIONS ON THE SCALP.

BUT few—will think of large fibro-cellular growths, and the tumour over known as adenomyoma of the scalp, all will require mention in a work like this.

FIBRO-CELLULAR GROWTHS MOLLUSCUM FIBROSUM, OR PACHYDERMATOCELE OF THE SCALP.

These rare growths occasionally require removal on account of their hideous deformity.* The chief points of importance in such operations are—1. The hæmorrhage. This may be terrific, and springing from every part owing to the large size of the growth and the vascularity of the parts. It is best met by an extensive preparation of Mr. Hutchinson's† and the prevention of an arterial hæmorrhage during an extensive operation of this kind by applying about the head, just above the ears, a Pezzi's contraindicator with a narrow strap, cotton-wool being placed over the eyes. Nostrils, and nostrils being plugged, which can be sterilised, string contraindicator bands will pass over the head at once, would be preferable. 2. The need of maintaining strict asepsis. As nearly the whole thickness of the scalp affected must usually be excised, the pericranium may be damaged and the bone consequently exposed. The risk of septic infection and even poisoning of the veins if

* A good illustration of these growths is given by A. Hutchinson, *Genl. Surg. Rep.* vol. 2, p. 249, and another by G. E. Bowen, *Surgey*, vol. 1, p. 111. The drawing in this case is not to be taken from a patient of Dr. V. as the surgeon drew an excellent one (*Med. Surg. Rep.* 1871, vol. 1, p. 111).

† It is as described by Dr. V. *Op. and Surg.* The patient is not anaesthetised in good condition, unless that is the case. In such a method of operating the skin was made use of, with excellent results.

‡ See *Op. and Surg.* The use of this contraindicator with the wire is not the pain of the head. It is the pressure of the wire on the skin. In Sir W. Stokes case the use of the growth was very much reduced, and the front of the right ear was exposed, and the bone was exposed, and the vertex and margin of the skull was exposed.

the diploë is well known, with the inevitable result of pyæmia. In very large growths two or more operations may be required. Thiersch's method of grafting (p. 233) will be very useful, either at the close of the operation or later on.

Recurrence is not unlikely even after extensive operations, and von Recklinghausen has shown that the proliferation of the connective tissue takes place along the nerves; it is therefore obviously possible that such tissue left along any of the nerves may serve as a fresh starting point.

ANEURYSM BY ANASTOMOSIS.

The treatment of these sometimes most difficult cases is given under the head of "Ligature of the External Carotid."

QUESTION OF OPERATIVE INTERFERENCE IN GROWTHS OF THE CRANIAL BONES AND DURA MATER.

Under this heading I shall refer to i. *Exostoses*, ii. those malignant growths, usually *Sarcomata*, which, springing from the scalp* (often the pericranium), the diploë,† the meninges, and, more rarely, the brain, are capable of perforating the skull from within outwards, or in the reverse direction. iii. *Epitheliomata*. These growths are the ones in which the advisability of operation is most likely to arise. i. *Exostoses*. It is only the ivory variety that needs reference here. The best incision to expose it is one transversely outwards from the root of the nose, through the eyebrow, and another upwards along the middle line of the forehead. The anterior wall of the frontal sinus must be freely removed with trephine or chisel, for it is essential to get at the root or base of the exostosis and to divide this, and not to merely break off pieces of the exostosis. For division of the extremely dense bone a burr worked by electricity is preferable to chisels and saws. Where the latter are relied upon several must be at hand. When the pedicle is detached there is often much difficulty in prising out the exostosis. The surgeon must be prepared for opening the posterior wall of the sinus and exposing the meninges, and perforating the roof of the orbit, and the delicate tissues of the ethmoid. In some cases it will be well to obtain leave to remove the eyeball. Careful drainage must be provided for the first few days in case of infection from the nose, and for the same reason, the wound should not be too closely sutured at first.

ii. *Sarcomata*. Periosteal, endosteal, and those originating in the dura mater. The following remarks by von Bergmann (*Syst. of Pract. Surgery*, by von Bergmann, von Bruns, and von Mikulicz (*Amer. Trs.* by Drs. Bull

* M. Terrier (*Bull. de l'Acad. de Méd.*, 1891, p. 184) records a case in which an epithelioma, starting in a scar, involved the dura mater over the frontal region. It was removed successfully, but the history is only carried up to two months after the operation. Other cases of carcinoma are given below, p. 243.

† While the vault is affected more often than the base, sarcomata of the skull may be present in both situations, simultaneously.

and Martin, vol. i. p. 142) may be useful. Sarcomata of the skull may be periosteal or central. The temporal bone is most frequently attacked, after this the frontal, parietal and occipital. Even at an early stage the surgeon has to face the question whether he is dealing with a sarcoma of the skull or one perforating from within. In the majority, whether periosteal, central, or from the dura mater, spindle-cells predominate. Those arising in the dura mater are characterised by calcification. Sarcomata of the skull show the same malignant features as sarcoma elsewhere, *i.e.*, fixity of the base and the same tendency to fungation. In large periosteal sarcomata the abundant blood supply may lead to distinct pulsation in the dilated tortuous arteries. At a very early stage this form shows a tendency to increase by secondary nodules, seated at first near the base of the original growths. This tendency to local dissemination, which can only be determined by the microscope, explains the frequency of recurrences. Metastases in the viscera, especially the lungs and in the bones, are very common. The lymphatic glands, as a rule, are not involved.

Only in the early stages, and under conditions rarely present, is it possible to determine whether a sarcoma of the skull is central, periosteal, or arises from the dura mater. If the surface be hard and bone-like it can only be a central sarcoma or possibly a local periosteal hyperostosis. In central sarcoma the surface soon becomes altered by softer areas which bulge outwards; often the summit of the swelling is soft while the periphery remains hard. In this way the appearance is very similar to that of a perforating sarcoma of the dura mater. The latter, however, never lifts up the bony wall of the skull but destroys it by infiltration; the growth is therefore surrounded by a bony ring. The latter is, however, on a level with that of the general surface of the skull, and does not, as in the case of the central sarcoma, extend from the base of the growth towards its summit. In the case of the central sarcoma the outer and inner tables feel as if they had been forced apart, while in that of the periosteal sarcoma the tables show a jagged edge.

If every periosteal sarcoma were composed only of soft tissues it would be easy to distinguish it from a central sarcoma, as long as the latter possessed a bony shell at its base, if not at its summit. However, osteo-sarcoma of periosteal origin, a frequent growth, has a bony feeling also, both at the periphery and summit. The latter possesses no bony shell, but numerous spicules of bone extend into the growth from the site of its attachment. On palpation these growths give the impression of a bony capsule, and this leads to mistaking an osteo-sarcoma for a central sarcoma. The most certain indication of the origin of a new growth in the diploë is the presence of the bony wall rising above the level of the surface of the skull and extending towards the summit of the growth. Sarcoma of the dura mater is recognised in exceptional cases only by the above-mentioned peculiarities of the gap in the skull, its situation within the plane of the surface of the bone, and its sharp outline. It may be diagnosed earlier by other symptoms. "If previously existing symptoms, especially those of intracranial pressure, disappear as soon or soon after a tumour appears at the surface of the skull, the surgeon is safe in assuming that the growth originated in the dura. Such a tumour begins to develop

within the cranial cavity, and brings about symptoms due to encroachment on the intracranial cavity. As soon as the tumour makes its exit from the interior of the skull the diminution of space and the combination of symptoms resulting therefrom cease. In the second place, perforating dural sarcoma usually pulsates as a result of the pulsation of the brain being transmitted to it. In the third place, such a tumour may be forced by pressure into the cranial cavity, causing temporary headache, slowing of the pulse, and loss of consciousness. If these three symptoms be present the surgeon can with certainty diagnose sarcoma of dural origin which has perforated the skull and continued to proliferate outside. Conversely, he cannot, however, exclude the dural origin of a growth in which these characteristic symptoms are absent. A tumour may be so closely adherent to the edge of the defect in the skull that no pulsation of the brain can be transmitted to it, or that pressure cannot force the growth into the cranial cavity. The presence of cerebral symptoms accompanying a tumour on the surface of the skull has no bearing on the differential diagnosis under discussion, for periosteal as well as myelogenous growths may proliferate inwardly as well as outwardly. The diagnostic importance of cerebral symptoms depends upon the fact that they occur before the tumour becomes noticeable, and disappear after it has made its appearance on the surface. As soon as the tumour reaches the surface of the skull it spreads out to an extraordinary degree, the defect in the skull becomes completely covered, and there is no longer anything to distinguish it from periosteal and myelogenous sarcomata, which similarly proliferate and attain an enormous size." *Treatment.* It remains to be seen what operative attacks, aided by modern surgery, may avail in these cases, but for the present, unless an opportunity arise for attacking such growths quite early—*e.g.*, while they are only of small size—it will be wiser not to interfere.* And this warning is especially true of those cases in which sarcomata of a specially malignant kind appear, often after an injury, on the crania on children,† where the swellings of the scalp are multiple, or where they are travelling out of the skull by any of the apertures, *e.g.*, the orbit. Large size, any evidence of fixity, duration of any length will cause any operation to be set aside, owing to the dangers of the operation, the possibility of its being incompleting, especially where the brain is involved, and the risk of its being impossible to close the gap. In addition to the question of metastases in such cases, the frequent presence of minute local secondary nodules (p. 239) must be remembered.

The following case is a good instance of these growths, though there

* Further carefully recorded cases, with post-mortem records, paying especial attention to the possibility of removal, are much needed here. An interesting case is published by Mr. Morris (*Path. Soc. Trans.*, vol. xxxi. p. 259). The disease here certainly took six years in running its course; other deposits were present. The patient died away from London. The growth is stated to have begun in the diploë, and to have compressed, not involved, the brain. Dr. Drummond, of Newcastle, published three interesting cases (*Brit. Med. Journ.*, vol. ii. 1883, p. 762). In none of them was any operation possible. Other instances of sarcomata of the cranial bones or the dura mater are figured by Tillmanns (*Textbook of Surgery*, vol. ii.).

† A good instance of such traumatic sarcomata is recorded, with illustrations, by Mr. Hewetson, of York (*Lancet*, vol. i. 1893, p. 1441).

was much uncertainty as to its exact origin. The question of operation, as mentioned below, was repeatedly discussed here.

D.E., aged 28, a Welsh miner, was sent to me, in 1885,* by Dr. Evans, of the Rhondda Valley. Three years previously he had noticed a swelling, the size of a pigeon's egg, in the centre of the right parietal bone; for a year previous to this he had pains in the head. During his work in the mine, his head had received repeated blows, many bluish, characteristic scars being present. A month after the swelling appeared, fits began to occur nightly, and lasted thus for three months; then they gradually became fewer, and for the last year there had been none at all.

At a spot 2 inches above the left ear was a large elevation of the scalp, measuring nearly $5\frac{1}{2}$ inches in one diameter, and about $4\frac{1}{4}$ in the other. There was no ulceration of the scalp tissues here, but unusually large vessels were to be felt over the area thus prominent. In the centre the bones of the skull appeared to be deficient over a circular spot the size of a shilling, as here the scalp could be deeply dimpled by finger pressure as if through a ring of penetrated cranial bone. Over this central gap, pulsation was strongly marked and rather heaving; it was also present, to a less degree, over the rest of the swelling.

At other parts of the area of the growth, especially at several spots in the periphery, was a remarkable feeling as if of bony, trabecular structure. It was doubtful whether this was brought about by growth invading a flat cranial bone, or to calcification taking place in the periphery of a sarcomatous growth. On a level with the left ear was an enlarged gland.

Mr. Targett, then Surgical Registrar, reported that double optic neuritis was present, but no oculo-motor paralysis. The reflexes were normal, and there was no loss of sensation or motion.

There were no urgent symptoms: the patient had occasional throbbing and pain in the swelling, but no obstinate headache and vomiting; he was able, as yet, to work, and stipulated that no operation involving risk to life should be performed.

For these reasons, and because, owing to the size, duration, and characters of the growth, the risk of attacking it was undoubtedly great, the patient left the hospital without any operation being undertaken.

Unless such a case can be seen very early (and this is just the stage which does not come under the notice of the surgeon), the following would appear to be amongst the difficulties and risks of an operation in these cases:

The necessary difficulty and tediousness in isolating the affected bone, if of any size, by sufficient trephine-crowns, and joining these with a Gigli's saw (p. 365), or the forceps of De Vibiss (p. 363), or a chisel.† It must be remembered that the overlying soft parts were extremely vascular and perhaps (from the enlarged gland) already involved in the growth. The position of these growths will not always admit of the use of an indiarubber band round the head. In isolating and going wide of the affected bone, it was uncertain whether one or more sutures would not have to be crossed, and sinuses, such as the superior longitudinal, met with and need securing (this, whether by underrunning or otherwise, not being always an easy matter), thus leading to profuse hæmorrhage. In addition to this source of hæmorrhage there is that certain to be met with in dealing with the soft parts

* He was still alive in 1890.

† The best means of removing bone from the skull on a large scale are given at p. 359. I would also refer my readers to Mr. Battle's instructive case (p. 243), and *Clin. Soc. Trans.*, vol. xxxii. p. 132.

and with the diploë around the affected bone,* unless this be extensively sclerosed, when another difficulty presents itself.

Then, supposing the bone sufficiently removed, wide of the growth, in many pieces, either because of its involvement in the disease, or to allow of further investigation in the case of a growth of doubtful origin, if this be found to arise from the dura mater, this membrane must certainly be dealt with, and the same would very likely be the case if, originating in the diploë, the growth had crept inwards. In further isolating the disease, if it had merely pressed upon the brain and not involved it, most delicate work would be required: enlarged branches of the middle meningeal and, very likely, dilated sinuses would require dealing with. If the disease had involved, instead of merely displacing, the brain, new and special risks would have to be encountered just when the patient's condition, after an already prolonged operation, was least fitted to bear them. Thus the operator may find that he is dealing with a non-encapsuled growth of the brain itself, and all that he can do is to try and shell it out with the finger or sharp spoon. Lastly, the arrest of all hæmorrhage and the possibility of closing the wound and gap in the skull, usually by a second operation, if the patient survive, have to be remembered.

Such are amongst the chief difficulties and dangers which appeared to me very likely, if not certain, to be met with. They do not seem to me to be exaggerated.

Moreover, in these and in any other prolonged operations which deal with the brain and its membranes, the fact must never be lost sight of that, what with the necessary interference with very vital organs, and what with the anæsthetic, the margin left to the patient between life and death may be a very narrow one.†

Even if the growth is small and circumscribed, and there is good reason to believe that it is single, it will probably be wiser to divide the operation into two stages, as in Mr. Battle's case given below, if the dura mater be involved.

* An attempted removal of a growth, afterwards proved to spring from the dura mater, is recorded by Sir W. Lawrence (*Med. Times and Gaz.*, 1853, vol. ii. p. 129). The operation was abandoned owing to the hæmorrhage. The patient died about two months later. Volkmann lost a patient with sarcoma of the dura, from the entrance of air into the superior longitudinal sinus.

† About fifteen years ago I had occasion to explore and attempt the removal of a glioma, proved later to occupy almost the entire right frontal lobe of a patient at Guy's Hospital. The pulse failed so ominously with chloroform that, after removing one crown, ether was given while the trephine was applied again, and the two openings thrown into one. The substitution of this anæsthetic was followed by so much cyanosis and jerky, gasping, irregular breathing, with a fixed chest (the patient was a young man, much emaciated by vomiting and headache, but free from any lung trouble), that it was decided to do no more that day. The patient never rallied, and died comatose a few hours later. In this case there had not been time to interfere with the brain and its membranes. Another patient of mine, admitted for epileptic seizures connected with a huge cancellous exostosis of the frontal bone, which, as it proved, was pressing inwards upon the brain and membranes, had been under observation for a fortnight, his diet being strictly regulated. On the evening of Christmas Day, his diet having been not unnaturally, but too suddenly, altered, a severe epileptic seizure came on; this was followed by coma, rapidly deepening into death. I have elsewhere (p. 263) alluded to the suddenness with which respiration may fail in patients the subjects of middle meningeal hæmorrhage.

The results given by von Bergmann (*loc. supra cit.*, p. 148), especially when due weight is given to his unusual experience and operative skill, do not seem encouraging. The last sentence referring to "cases apparently permanently cured" is too vague to be of any real value. "The author has done extensive resections in four cases of cranial sarcoma; in one of these the patient died. The tumour had proliferated to a considerable depth into the occipital lobe, and the profuse bleeding which resulted caused collapse. The three other patients recovered. Two died at the end of one and a half and two years, respectively, as a result of recurrence of the growth. Regarding the fate of the third, he was not able to obtain any information. Grünberg investigated the histories of all operations published during the last two decades. Twenty-two operations were performed on seventeen patients. In three cases, two or more attempts at interference were made necessary by recurrence of the growths. Of these twenty-two operations, five were not completed, partly because of hæmorrhage, partly on account of collapse, and partly, owing to the too great extent of the growths. The operation was completed in seventeen cases. Three of the patients died as a result of the operation, death being caused by entrance of air into sinuses, thrombosis of sinuses, and cerebral abscess. In seven cases recurrence took place soon after the operation. In two no information was obtainable. Of seventeen cases, five were apparently permanently cured, which is a good result, considering the certainly fatal termination otherwise."

iii. Another similar but distinct class of these growths is formed by those *epitheliomata* of the scalp which have extended through the cranium to the dura mater or even the brain. Tillmanns (*Surgery*, vol. ii.) gives good illustrations of two such epitheliomata involving the frontal region: one, in a girl of 14, which perforated the skull, was successfully removed by Braun; the other, in a man of 56, was operated on by Tillmanns. Here recurrence rapidly took place. A very instructive case of carcinoma* of the frontal region, involving the skull, was successfully operated on by Mr. Battle (*Clin. Soc. Trans.*, 1899, vol. xxxii. p. 127):—

The patient was 35, and during the previous eight years several operations had been performed. The growth measured 3 inches by 4½, bled freely, and could not be moved over the subjacent bone. There was no pulsation in it, and the glands appeared to be normal. Removal was effected by operation in two stages: "Cotton-wool having been placed over the eyes, a Martin's bandage was passed round the head below the occipital protuberance and over the root of the nose; an incision was then made to the bone about ½ inch from the edge so as to completely encircle the growth. The mass was then rapidly separated from the bone with the handle of the scalpel and a periosteal elevator. The only hæmorrhage came from places in the bone which had been invaded by the growth, and firm pressure with a sponge readily controlled it. Several vessels were then secured, but after the removal of the Martin's bandage there was pretty free bleeding. Pressure arrested this until vessels could be caught. Several arteries required ligature, and one or two a ligature passed round them by means of a curved needle. On the whole, there was no great loss of blood. The sponge placed over the growth where it passed into the bone was left in position, and the dressings were applied firmly over this. Next day the dressings and the sponge were removed, and extra pressure was no

* Mr. Shattock pronounced the growth to be a spheroidal-celled carcinoma, probably originating in the glandular structures of the skin.

longer applied. It was evident that the bone was affected to a considerable extent, although it was not certain that the growth had passed completely through in more than one place."

On a later occasion—the exact date is not given—the bone was removed partly by a hand-motor working a trephine and circular saw fitted with a special guard,* and partly by a chisel and Hoffman's forceps. "The amount which required removal was placed about the centre of the frontal bone, and was about $2\frac{1}{2}$ inches in width. A trephine-crown was removed to the right of the area marked out; there was a good deal of difficulty in doing this, as the bone was very hard and thickened. A raspator was then passed under the bone to determine whether the growth implicated the dura mater; this could not be made out with certainty. There was some difficulty in starting the saw owing to the great thickness of the bone. A chisel and Hoffman's forceps were accordingly used to make a beginning, and the saw applied afterwards. By the alternate use of these instruments about a third of the circumference was divided. The saw was then started in the other direction from the trephine-hole, and worked much more quickly, till there was only about an inch left uncut. Up to this time there had been very little bleeding, but now bleeding was free. A chisel was used to cut through part of the remaining bone, and then the circle of bone was raised from the other side, and the last piece gave way. The bleeding was seen to come chiefly from a point in front in the middle line in the dura mater, just under the edge of the bone. Bleeding from this point was temporarily arrested by finger-pressure. The under surface of the bone presented in one part an area of softened tissue about the size of a raisin. The appearance of this was very like that of a flattened papillomata sometimes seen on the palate; this growth did not in any way involve the dura mater—in fact the dura mater was quite healthy." The bleeding point in the dura mater was arrested by pressure with gauze-packing. At a later period the granulating surface was grafted.

Mr. Battle's remarks on the mode chosen for removal of the cranial bone are very noteworthy: "Of the principal methods of removing large portions of the skull, the one which was brought to my notice by Messrs. Down—that of a circular saw worked by a motor—appeared the most likely to fulfil the object in a satisfactory manner. There was, however, much difficulty in guiding the saw along the line which I had selected, and it travelled slowly through the dense bone, whilst the cable attached to it was cumbrous and difficult to hold. Were I again called upon to perform a similar operation, or one requiring the excision of much bone, I should use the method, since suggested, of the wire saw, worked across from one trephine opening to another, and applied from within outwards" (p. 365).

* Supplied by Messrs. Down. The use of electro-motor trephines is referred to on p. 363.

CHAPTER II.

TREPHINING.

OPERATIVE INTERFERENCE*, IMMEDIATE OR LATER †, IN FRACTURES OF THE SKULL.

Indications.—The chief of these are :

i. COMPOUND DEPRESSED FRACTURES.—Whether symptoms of compression are present or no, these fractures should, as a rule, be explored by reflecting adequate flaps, then elevating any depressed fragments, and removing any which are quite loose. At the same time the surface of the dura mater, where exposed, should be carefully scrutinised, and, together with the rest of the wound, thoroughly cleansed.

With regard to "thorough cleansing," I may draw the attention of my younger readers to the following forcible remarks of Prof. Nancrede (*loc. supra cit.*): "Suppose a recent head-injury just brought into the hospital, how should we proceed? Do not carelessly pass the forefinger through the filthy, blood-matted hair and explore at once the depths of the wound to ascertain its nature, as is too commonly the rule, but carefully shave the scalp, scrub it with a nail-brush, soap and water, remove all fatty matter with ether or turpentine and alcohol, completing the disinfection by a thorough irrigation with mercuric bichloride solution." When the patient is under an anæsthetic it will be well in some cases to cut away any badly contused portions of the scalp which cannot be disinfected, and to use a small curette where foci of dirt are ground in. Later, cleansing may still be incomplete unless a chisel is used to set free hairs or other small foreign bodies which have been caught in a fissure, or to follow up one of these owing to its infected appearance.

Operative interference is indicated in these cases for two reasons: (a) Even if no symptoms of compression are present at first, secondary inflammation is very likely to follow in a few days, it not having been possible by expectant treatment to completely cleanse the wound. If, now, some minute fragment of the brittle inner table has pricked the dura mater, fatal infective meningitis is almost certain. Should, therefore, the surgeon, in these cases, wait for evidence of compression as a justification of operative interference, he will too often wait till it is too

* This term is used to include the use of the elevator and dressing-forceps as well as that of the trephine, a matter which is alluded to again below (footnote, p. 251).

† By these terms it is intended to make a distinction between those cases in which operative interference is required a few days after a fracture, and those in which it is required immediately after the injury (see p. 272, "Trephining w

late. Evidence of the presence of dirt,* especially of dirt ground down to, or into, the bone, is a reason for exploring the wound, even if no symptoms of compression are present. (b) If the patient recover from the immediate effects of the fracture, injury to the inner table, insufficient to cause symptoms at the time, and not detectable save by an operation, may be present all the time and cause much future trouble. In the words of Prof. Nancrede (*Intern. Encycl. of Surgery*, vol. v. p. 24): "Undoubtedly, many patients recover in whom the bone is not elevated, but in too many epilepsy, insanity, chronic cerebral irritation, &c., render life a burden, and operations are then required, which often prove useless.† . . . Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation driving the dura mater against the bony fragments, Nature throws out osteophytic growths, which eventually—perhaps after years—set up serious trouble." The surgical treatment of traumatic epilepsy is now, when a large number of cases operated upon have been honestly watched, found to be very disappointing (p. 273). It is by a more frequent immediate exploration of all doubtful injuries to the head that we may best hope to bring about a diminishing frequency of traumatic epilepsy. (c) Locality is, of itself, an indication for interference. Thus aphasia may follow on a fracture over the region of the anterior inferior angle of the left parietal, and paresis on one, apparently trivial, over the motor area. Moreover, it is injuries to the frontal and parietal regions which, if left unexplored or insufficiently treated, are so liable to be followed by epilepsy.

A word of warning is needed here. While the more localised is the depression of a fracture over the motor area, the more will the surgeon be justified in interfering; he must not be certain that he will thereby prevent epilepsy in the future. Von Bergmann's words on this matter are weighty ones (*Syst. of Pract. Surgery, Amer. Trans.*, by Dr. Bull and Dr. Martin, vol. i. p. 98). "As a matter of fact, epilepsy occurs as frequently in connection with head injuries in which no fracture exists. Depression is no more a factor in the etiology of this disease than any other scar of the brain or external soft parts that has become adherent to the skull. At present it is known that where an act of violence not exceeding the limits of elasticity of the skull flattens or bends in the latter without producing fracture, the portion of brain underlying the

* To prove that it is not only the risk of pressure on, or injury to, the brain, but also the entrance of infective matter, that indicates the use of the trephine, Wagner (*Volkmann's Samml. klin. Vorträge*, pp. 271, 272)—I am indebted to Prof. Nancrede for this reference—points out that it has been shown in more than one instance that even a hair caught in a fissure will certainly produce infection if not promptly removed. The same writer puts the mortality of immediate trephining at only 1.23; that when twenty-four hours or more had elapsed, at 33.33 per cent.

† Dr. Gunn (*Trans. Amer. Surg. Assoc.*, vol. i. p. 89), speaking of later trephining for the relief of old depressed fractures, says: "Although results of these secondary operations do not show a flattering percentage of success, I think that the reason may be looked for in the late period at which the operation is performed. It is rare that the patient submits to the dreaded operation till years have been wasted in the vain endeavour to effect a cure by medication. In the meantime, the constant irritation has begotten a permanent impression upon the brain and nervous system which remains after the offending point of irritation has been removed."

point of impact may be contused. The depressed fragment of skull, being elastic, springs back into its former position, but the portion of brain injured at the moment of depression undergoes a sclerotic degeneration from which may originate an attack of Jacksonian epilepsy; the same may take place as the result of damage to the cerebral cortex following depressed fracture."

ii. SIMPLE DEPRESSED FRACTURES.—Where symptoms of compression are present, operative interference is the only course open. But where no such symptoms are present, the expectant treatment is by most surgeons held to be sufficient. We may perhaps come best to a decision as to using operative interference in simple depressed fractures, without symptoms, by dividing them into the three following groups:—

1. Where the depression extends over a considerable area, where it is slight in degree (*e.g.*, not more than a sixth of an inch), especially if the patient be young and the bones yielding, expectant treatment is no doubt the best.

2. But, on the other hand, where the depression is limited and defined, where the depressed fragment not only affects a small area, but is turned down angularly or edgeways, operative interference should be resorted to at once, even though no symptoms are present, and whether there is a wound or no, to prevent the onset of dangers, immediate and remote, fully alluded to later on.

3. There is a large class of cases intermediate between the above, where the fracture is a simple one, where symptoms are absent, and where the depression is sufficient to cause anxiety, though not so sharply defined as to call imperatively for operation. Here, when in doubt as to the severity of the case, the surgeon, if able to rely on his operative skill and on the wound running an aseptic course, will do best to explore the fracture. This is especially the case in fractures of the frontal and parietal regions, owing to the frequency with which these are followed, at a later date, by epilepsy.

Finally, in any fracture in which the question of operative interference arises, the kind of violence must be remembered. Was this concentrated over a small area, and thus likely to bring about serious depression and comminution of the internal table, or was it indirect and diffuse, and thus likely to have produced a long fissure-fracture with little depression, but perhaps tearing open meningeal vessels or sinuses, opening up the middle ear, nose, or pharynx, and spreading far into the base?

Influence of Site.—It is often said that a depressed fracture, even if distinctly marked, over the frontal sinuses, does not require operative interference, and that any such steps should be avoided for fear of leaving a fistulous opening leading to passage of air and troublesome emphysema. But it must be remembered that these sinuses do not appear before the age of fifteen or sixteen, and that, even in adult skulls, the extent of their development is most uncertain, the sinuses being sometimes represented by a small unilateral cell instead of fair-sized bilateral cavities.* Other sites, which it is well to avoid in

* Hilton, *Guy's Hosp. Rep.*, second series, vol. viii. p. 362. *Notes on the Cranium*, p. 8 *et seq.* See p. 317 for a case of fatal injury to this region.

trephining, if possible, are the position of large venous sinuses,* that of the trunk and chief branches of the middle meningeal artery† and also the lines of the sutures, apart from any subjacent sinuses, as here the dura mater is firmly attached, unless it chance to be loosened by a violent blow. *Age*, too, must have proper weight attached to it, it being well known that in the first few years of life a very considerable depression may take place after an injury, and yet be followed by absence of head symptoms and by spontaneous recovery.†

iii. PUNCTURED FRACTURES.—Here, however slight be the injury to the outer table, that inflicted upon the inner is certain to be much more serious. And the more the diploë is present, the more extensive will be the damage which its fragments, when driven down, will inflict upon the brittle inner table. It must be remembered that punctured fractures, with all their serious results, may be caused by blunt, though pointed, bodies as well as by sharp ones. Instances of these are, blows with a pickaxe, fragments of brickbat, coal, stone, the trigger of a clubbed gun, or falls on a fender-ornament. Immediate operative interference—and here, owing to the limited injury to the outer table,

* It is worth while to bear in mind that if a large venous sinus is opened, the hæmorrhage can be, usually, at once arrested by *very moderate pressure applied at the right spot*. The pressure should be made by a sterilised finger, and kept up if needful by a pledget of sterilised aseptic gauze, left *in situ* for two or three days if possible. Sir H. Cameron (*Lancet*, 1884, vol. i. p. 931) was able to complete a trephining while very slight pressure with lint controlled the bleeding from a wound in the superior longitudinal sinus. He points out that the imaginary fear of fatal hæmorrhage from such a wound may at times deter from a necessary operation with the trephine, and it is well that it should be dissipated. Dr. Hopkins (*Ann. of Surg.*, vol. ii. No. 7, p. 67), in a case of extensive compound fracture of the skull, found that a small lint-compress, dusted with iodoform, lightly applied to a wound in the superior longitudinal sinus exposed by elevation of fragments, readily arrested the hæmorrhage, which persevering efforts with tenaculum-forceps had failed to check with a ligature. Dr. Parkes (*Ann. Anat. and Surg.*, vol. viii. p. 118), in treating a wound caused by a fracture of the skull, arrested the terrific hæmorrhage first by pressure, and then by introducing three fine cat-gut sutures. These entirely closed the rent and controlled all bleeding, and though the calibre of the sinus was reduced fully one-third, and the sinus bulged markedly at the anterior extremity of the sutured wound, showing interference with the backward blood-flow, there was no evidence of cerebral disturbance due to this interference with so large a column of blood, the wound healing well with antiseptic precautions. The strictest antiseptic methods should be employed in dealing with wounds of these sinuses owing to the great risk of septic phlebitis and pyæmia.

† The treatment of hæmorrhage from the middle meningeal artery is given at p. 265.

‡ Good instances of this are given by Mr. Le Gros Clark (*Diagnosis of Visceral Lesions*, p. 94), Mr. Bryant (*Surgery*, 2nd ed. vol. ii. p. 357), Prof. Nélaton (*Pathologie chirurgicale*, tome ii. p. 149). The last two are accompanied by illustrations. On the other hand, a case by Dr. Haynes, of Evesham (*Brit. Med. Journ.*, 1897, vol. i. p. 203), shows that urgent symptoms may arise very early in life. A child, aged two years and five months, after a slight fall was found to have a deep indentation on the upper part of the right side of the head, and convulsive twitchings of the left arm and leg. Dr. Haynes, on exploring the injury, found a fracture "with a good deal of depression." An uninterrupted recovery followed after trephining and elevation of the bone.

Dr. Nicoll (*Ann. of Surg.* 1904, vol. ii. p. 868) prefers to operate in cases of birth-fracture, especially where these have become depressed. The depressed fragment is cut out with a large trephine. The bend being reduced the cranium is closed, inverted, upon the dura, and the flap sutured.

the trephine will be called for—is imperatively demanded in all punctured fractures, however insignificant be the damage to the scalp and outer table.*

iv. IN SOME CASES OF FRACTURE ABOUT THE INNER ANGLE OF THE ORBIT.—Those grave injuries which may be caused by direct violence from thrust-wounds at the inner angle of the orbit, or root of the nose—*e.g.*, with scissors, slate-pencils, ferrules of walking-sticks, &c., should always be explored at once.

An incision should be made from without inwards along the supra-orbital arch, just below the eyebrow, to a point within the puncture: a flap should be turned down, the eyeball gently depressed, and the inner wall of the orbit and adjacent parts carefully chipped away with a small chisel or gouge. The hæmorrhage from the angular vessels is troublesome. Any foreign body or infective material is thoroughly removed; the dura mater is also inspected. If this be lacerated it and the subjacent brain should be thoroughly wiped over with pure carbolic acid, and the cavity carefully plugged with sterilised gauze, a drainage-tube being used as well, if needful. A fomentation of boracic acid should be used, and the gauze changed daily at first.

The apparent slowness of these injuries, the trifling wound—owing to the mobility of the skin and the slowness or absence of any sub-conjunctival hæmorrhage, the wound may appear not to have perforated the orbit—the period of latency of symptoms, and the onset of fatal brain mischief—inevitable, though delayed, if let alone—are all well shown in the following case of Mr. Hulke's:†

A little girl, aged 6 years, falling with a piece of slate-pencil in her hand, it pierced her right eyebrow near its inner end, and broke short off. Admitted soon after into Middlesex Hospital, the house-surgeon took out of the wound several splinters composing, he thought, the whole piece, covered the wound with a pad of lint, and had the child placed in bed. Her general condition did not betray the serious nature of the injury. She slept quietly through the night, and next morning did not appear much worse for the accident. In the afternoon, when I then first saw the child, I detected with the probe another splinter of the pencil, and, enlarging the little puncture, exposed a piece of pencil tightly plugging a hole in the bone. Enough of this was cut away cautiously with a gouge to allow the pencil to be grasped with a forceps. It proved to be shattered, and splinters representing a cylinder three-quarters of an inch long were removed. Intracranial inflammation—indicated by convulsions, delirium, a high temperature (103°) and rapid pulse—supervened. On the ninth day after the injury the temperature fell to 97.5° (the child had passed a quiet night, and took her food better), and from this date it continued

* "Hence it follows that exploratory perforation of the cranium is justifiable in all cases where the nature of the impinging force or the appearance of the external table renders spiculation of the inner table probable; provided that less danger to life and health is inherent in perforation than in the probable spiculation. . . . Whenever the fracture presents the possibility of the inner table being detached and splintered more extensively than the outer, I should be inclined to advise perforation. In other words, I would cut the scalp to see the condition of the outer table, and I would cut the bone to see the condition of the inner table, in every case where the risk of obscure knowledge is greater than the risk of divided scalp and perforated bone."—Dr. Roberts, *Ann. of Surg.*, vol. ii. No. 7, p. 14.

† *Syst. of Surg.*, vol. i, p. 586. As here pointed out, the injury is especially likely to be overlooked if the instrument has slipped under the lid, and so reached the roof of the orbit and base of the skull, leaving, it may be, merely a patch of ecchymosis on the conjunctiva.

subnormal, or only slightly exceeded the normal average, until the sixteenth day, when it rose suddenly to 104°. With this elevation of temperature were associated restlessness, delirium, a flushed face, screaming, vomiting, convulsions, and coma. Death occurred about twenty-four hours later. At the necropsy, a large abscess was found in the frontal lobe of the right hemisphere. It enclosed a piece of pencil about an inch long, and it had evidently quite recently burst into the anterior horn of the lateral ventricle. It is a matter of regret that the trephine was not employed instead of cutting away the bone around the pencil, which had the effect of loosening the splinters, and contributed to the fatal mistake that the whole piece of pencil had been removed.

V. FOR THE REMOVAL OF FOREIGN BODIES FISSURING OR FRACTURING THE SKULL.—These are rare—*e.g.*, penknife-blades, pieces of stone, bullets, &c. To ensure certainty of complete removal the trephine will usually be required.

The following cases show how the gravest results may ultimately follow on the overlooking of a small piece of knife-blade. Both (the first case especially) are good instances of the long time which occasionally intervenes between the injury and the onset of urgent symptoms due to abscess.

The first case is given by M. Dupuytren:*

"Il y a huit ou dix ans, un jeune homme reçut dans une querelle un coup de couteau sur le sommet de la tête; ce couteau se rompit dans la crâne, après l'avoir perforé. Le chirurgien qui pansa le malade n'examina point avec tout le soin désirable l'état de la plaie; il en rapprocha les bords, et le malade guérit. Plusieurs années se passèrent sans accidents; seulement, de temps en temps, la malade ressentait des douleurs dans sa cicatrice. Au bout de quelques années, sans cause connue, il lui suivait un assoupissement très-fort de la fièvre; il vint à l'Hôtel-Dieu et y fut reçu. En examinant sa cicatrice, je sentis qu'elle était soulevée et dessous elle un corps étranger; j'incisai et fis l'extraction d'une portion pointue de lance de couteau, à l'aide du trépan. Les accidents persistèrent, il s'y joignit la paralysie du côté du corps opposé à celui de la tête qui était blessée. J'incisai la dure mère, il ne sortit rien; je plongeai un bistouri avec précautions dans le cerveau, et il jaillit de suite un flot de pus. Le soir même de cette opération, tous les accidents disparurent, la fièvre, la somnolence et la délire; et le malade guérit."

In the following case of Prof. Nancrede's,† the apparent slowness of the injury, the long absence of symptoms, then their sudden onset, the difficulties met with during trephining, the results of promptly meeting them, and finally, death due to a hernia cerebri, are all deserving of careful attention:

On March 6th, J. Y., aged 19, walked into the Episcopal Hospital, complaining of a sore on the top of his head, the result of a blow received two months previously. On examining the wound, in the centre of an ulcer, located about the position of the left middle parietal lobe, was found the broken edge of a knife-blade. On being told of this he seemed thoroughly surprised. But little could be made out as regards the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not, at that time or afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed, but in the afternoon of the same day he had slight pains in the head. March 7: He had slept well. No headache, temperature 100°. Slight retinal hyperæmia. March 8: Epileptiform seizures set in to-day, beginning with twitching of the right arm, but soon becoming general. Prof. Nancrede trephined over the seat of injury, the bone

* *Leçons orales de Clin. Chirurg.*, second ed. t. vi. p. 146.

† *Intern. Encycl. of Surg.*, vol. v. p. 83.

removed showing a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. During the next three weeks the fits apparently ceased, but symptoms indicating cerebral abscess—viz., temperature often low, $97\frac{1}{4}^{\circ}$ - 98° , slow pulse, marked mental dulness—set in. March 30th: Temperature 99° , pulse 70. The patient was unconscious, with right-sided hemiplegia, and rapidly sinking. Prof. Nancrede, on reflecting the flap covering the trephine-hole, found it filled by the tensely stretched dura mater, pulsating strongly. A small incision was made through this, but nothing was evacuated. The coma rapidly deepening, an aspirator-needle, connected with a vacuum, was passed in at three or four different spots to the depth of $\frac{3}{4}$ inch, but with no result. Feeling convinced that pus was present, and from the symptoms that it was compressing the ascending frontal and parietal convolutions, Prof. Nancrede proceeded to set a large-crowned trephine in front of and below the first opening, which was slightly behind the fissure of Rolando. Before the skull was half divided both pulse and respiration ceased. The operation being rapidly completed, the dura mater was incised without result. At this moment a large drop of pus oozed up through one of the aspirator punctures. A knife being plunged into the brain substance, from 1 to 2 ounces of pus were evacuated. The patient appeared to be quite dead, but vigorous and prolonged artificial respiration revived him. The next day a hernia cerebri as large as a walnut was protruding from the wound in the dura mater. This increased in size, and broke down, the patient dying on April 4. At the autopsy the left parietal lobe formed an enormous abscess cavity, the abscess being superficial, and destroying the greater portion of the upper part of the left hemisphere.

TREPHINING* IN FRACTURED SKULL

(Fig. 106).

The scalp having been shaved and thoroughly cleansed (p. 245), the patient brought under the influence of A.C.E. or chloroform,† unless a condition of unconsciousness renders this unnecessary, the head is supported on sand-bags at a convenient height. The fracture is next exposed, the old-fashioned crucial, T- or Y-shaped incisions being now, when possible, replaced by the semilunar flap of Sir V. Horsley.‡ The flap should be so arranged as to fully expose the field of operation on the skull. Its base is usually below to secure a good blood supply.

* It has been already stated that in many cases of depressed fractures, after exposure of the fragments, a pair of dressing-forceps and an elevator may do all that is required. Where no trephine is at hand, a chisel and mallet should be used. As there is no fluid collection here there is not the same objection to the percussion of the mallet. As soon as the dura is exposed, the proper cranial chisel with a shoulder (Fig. 139) is always to be preferred. That the trephine itself is not always needed should be clearly understood, as it is probable that elevation of fragments might often most wisely have been performed had it not been for the absence of a special instrument, wrongly supposed to be essential, or for the dread of an operation of undoubted severity with its necessary laceration of the vascular diploë, and requiring delicacy and skill also.

† I much prefer these anæsthetics, if possible, in cases of trephining, on account of the greater excitement and congestion which are usually associated with ether. But whenever it is possible, and especially when the pulse and breathing are falling, anæsthetics should be dispensed with. Where there is any tendency to drowsiness or coma "the anæsthetist should attempt to secure an analgesic rather than a true anæsthetic state" (Hewitt, *Anæsthetics and their Administration*, p. 54).

‡ The flap has these advantages:—(1) It is readily detached, and (2) it exposes the bone freely. (3) It allows of more thorough use of antiseptics. (4) It prevents the occurrence of a hernia cerebri.

The incision goes down to the bone, and the pericranium is divided, with the flap raised cleanly and uniformly with an elevator. If it be needful to operate through the temporal muscle, its fibres must be sufficiently severed and raised with the flaps, it being somewhat more difficult to separate the periosteum here, on account of its thinness in this region, and more intimate adhesion to the subjacent bones.* In reflecting the flaps, free hæmorrhage is nearly always met with, especially in the case of the chief superficial trunks and the deep temporal arteries, but this is promptly and easily arrested by the use of Spencer Wells's forceps, which act as most useful retractors, taking up but little room, while at the same time they arrest the hæmorrhage. It is always difficult, owing to the density of the tissues, to take up the vessels neatly here. It is quite permissible, especially in urgent cases, to take up the whole thickness of the flap. Owing to its vascularity it will not slough. No sutures should be inserted just at those spots where the forceps have been applied. If bleeding continues from any crack in the bone which may now be found, it will only cease on the elevation of the fragment, or on the exposure of, and the dealing with, any subjacent clot. The fracture being now in view, if it be found impossible to introduce an elevator, strong dressing- or sequestrum-forceps, even after sawing off any projecting angle of bone, the surgeon must decide where to place his trephine. In doing so, he must choose a spot, if possible, clear of a sinus (p. 248) or large branch of the middle meningeal artery (p. 264),† and one which will at the same time support firmly the pressure needed in the working of the trephine. Thus the pin and the greater part of the trephine-crown are placed on sound bone (Fig. 106), while a small part of the trephine usually overhangs a depressed fragment. But if the surgeon fears that the fragments are in contact with the dura mater, and perhaps injuring it, and that the jarring movement of the trephine coming in contact with one may be pernicious, he will so place his trephine that it rests entirely on sound bone, any intervening bridge being easily cut away. A spot being thus chosen, a trephine of about 1 inch in width is taken‡ with the centre-pin protruded for about a tenth of an inch, and firmly fixed in this position, the trephine being so grasped in the hand that the index finger steadies the centre-pin screw when the bone is entered. The instrument is now firmly applied to the bone, the centre-pin being bored inwards, and as soon as the teeth feel the bone the trephine is worked from left to right and then from right to left, care being taken to exert equal pressure in both directions. While the first groove is being cut, the movements of the trephine must be light and quick, but without jerking, the tendency of the instrument to slip being met by steady bearing on the the centre-pin, and by keeping the left forefinger at first on the bone close to the trephine.

As soon as a groove sufficient to keep the trephine steady has been cut, the pin is drawn upwards, and so fixed. The rotatory movements

* The greater thickness of the soft parts which will here form the cicatrix will, in a measure, make up for the difficulty in preserving the periosteum.

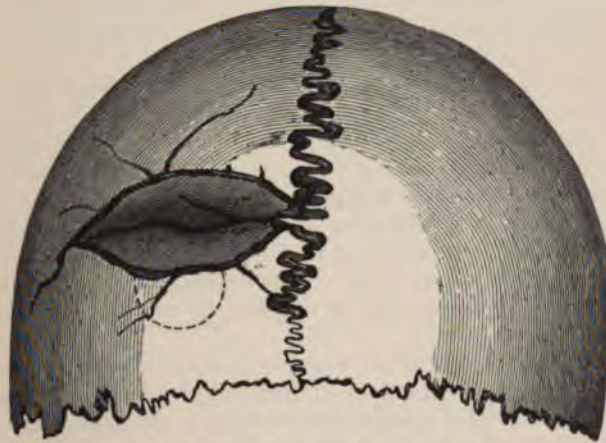
† If it is really needful to trephine over one of these vessels, the remarks at p. 265 will show how the hæmorrhage should be met.

‡ Other means of removing bone are referred to below, p. 359.

alternating from side to side are now continued, care being taken to bear as evenly as possible on every part of the circle, till the diploë* (if this be present) is reached. This is known by the easier working of the instrument, and by the softer sound. On the living body at least, owing to the oozing from the vascular parts around, the blood-staining of the bone-dust described as taking place at this stage is liable to be fallacious.

Throughout the operation, but especially now as the thinner table is being reached, every care must be taken to keep the circle of equal depth—(1) by pressing on the saw evenly; (2) by making it bite in equally from right to left and from left to right; (3) by remembering that, owing to the skull being spheroidal in shape, it is impossible, without the greatest carefulness, to keep the groove of equal depth all

FIG. 106.



Compound depressed fracture of "gutter" form. There being no comminution, the trephine has been placed close to, and in part overhangs, the fracture. (Hutchinson.)

round; (4) by bearing in mind that while the average thickness of the adult skull is one-fifth of an inch, the thickness varies so much that it is almost always greater at one part of a trephine-circle than at another.† Thus at frequent intervals the flat end of a trephine-probe, or a quill cut to a point (either being first sterilised), must be carefully introduced at different spots, and when the circle is found to be deeper on one side (still more if it is perforated) the trephine must be so slanted

* This is absent in early life and in the aged. Again, over a large part of the squamous bone and in the occipital fossæ, diploë is never met with. Thus, in cases where the diploë is absent, especially in the thinned calvaria of an aged corpse, it is quite possible, by using haste or force, to jam the crown of bone in upon the brain.

† Mr. Holden's words (*Landmarks*, p. 5) are excellent: "Think that you are operating on the thinnest skull ever seen, and thinner in one half of the circle than the other." Sir A. Cooper (*Surgery*, vol. i. p. 188) thus speaks of the operation: "Some people say that this is a trifling operation, not difficult to perform, nor dangerous; but they deceive you; it is one of the most dangerous operations in surgery; whilst performing it there is but a single step—a small network—between your patient and eternity."

that its teeth are only cutting on that part of the groove which is still shallow. When the groove has been made sufficiently deep, and careful examination finds three or four points of penetration, the bone may be removed by inserting the elevator at the deepest part of the groove and lifting up the disc of bone by carefully making a fulcrum of the sound bone or of a finger.

If profuse hæmorrhage occur on raising either the disc of bone or a depressed fragment, it will probably come either from a branch of the middle meningeal artery or from a sinus. The treatment of the former is given at p. 265: in the latter case pressure should be at once applied by means of a pledget of sterilised gauze; if this has to be tucked under an edge of bone to control the bleeding, a ligature of sterilised silk should be fastened on to it, to secure its withdrawal in about three days' time (p. 248).

In the case of a punctured fracture, a full-sized inch trephine should be applied, so as to remove the outer table around the immediate neighbourhood of the puncture, and thus expose freely the damage to the inner table.

If after removing a crown of bone more room is still required, this may be obtained either by taking out a second crown close by, and joining the two, or by the use of a Hey's saw or the forceps of De Vilbiss (p. 363), or of Hoffman's forceps; if the latter instrument be used it must be of reliable temper.

Sufficient drainage must be provided in those cases which require it, *e.g.*, where infection is present, or where a large cavity is left under the flap, in which fluid will collect. Any drainage-tube used should be brought through the lowest part of the flap, by puncture if needful, and stitched to the skin.

Where it has been needful to remove bone extensively the question will arise as to the best means of diminishing the gap. In many cases the trephine-crown or bone fragments, as long as these are not too small, unite readily if they have been kept in a hot, sterile saline solution, the temperature of which has been maintained. In many cases, often when their survival is most desired, they fail to unite. They cannot be used in compound fractures where they are perhaps infected; in cases where the dura mater and brain has been injured and any cavity or irregular surface exists. In cases of trephining for traumatic epilepsy their replacement would, in my opinion, be injudicious, it being here desirable to leave a safety-valve for the relief of future varying tension. Where the scalp has been extensively destroyed the surgeon may, if the patient's condition admit of it, diminish or close the gap by means of one or more pedunculated flaps. But, as a rule, this will be left to a later stage. German surgeons, König and Müller, have advised that such flaps, for the better protection of the brain, should be raised with periosteum and the outer table, by holding the chisel horizontally. This is a severe operation, and only possible where the bone is well developed. It cannot be employed in children owing to the non-development of the diploë. Another method is the employment of grafts of decalcified bone, recommended by Senn. Here all scar tissue and the edges of the adjacent bone must be completely removed, so that the graft will fit exactly with the cavities of the diploë round the margin of the gap. The graft must be covered

with the scalp, by a pedunculated flap, if needful, and strict asepsis is necessary for success.

The terse summing up of Dr. Amidon (*Ann. of Surg.*, No. 3, vol. i.) may here be quoted: "Let the operation always be done with antiseptic precautions. Try and secure only proximate coaptation of the flaps. Provide the freest possible drainage. Use cold* antiseptic dressings without much compression. Enjoin the strictest quiet in a posture facilitating drainage."

I have, hitherto, been speaking of those conditions which call for *immediate* or *primary* trephining.

The following will be amongst the *intermediate* or *secondary* conditions which may suggest trephining some days or weeks after an injury to the skull. Long continued unconsciousness, as when this lasts over twenty-four hours, no other cause than the injury being present. Severe pain if organic. Convulsions, especially if localised and associated with aphasia. Paralysis, especially if marked and occurring in adults. Dennis (*Med. News*, Mar. 21, 1903) refers to a case of a child who fell on the pavement from a third storey, sustaining an indented fracture of the parietal bone.

The compression was sufficient to produce hemiplegia of the opposite side and deep coma. Dennis so manipulated the sides of the head as to cause the indentation entirely to disappear. As soon as the bone sprang back to its normal position the child passed at once from deep coma into complete consciousness, and the hemiplegia instantly disappeared (p. 248).

The possibility of a linear fracture causing a depression of the inner table has often been overlooked. Messrs. Shield and Shaw report (*Lancet*, Feb. 14, 1903) an interesting case of this kind.

The patient, a healthy man, æt. 30, sustained a scalp wound in the left frontal region. No fracture was found, and the man was confined to bed for a short time for concussion. He was perfectly well for some weeks, but, about a month after the injury, he began to suffer from pain in the head, loss of memory and sudden outbursts of passion. He gradually reached a condition of dementia. There being no history of alcoholic excess or syphilis the symptoms appeared to be directly one to the injury. Shaw trephined at the seat of injury and found a healed linear fracture with a depression of the inner table. The operation was immediately followed by a most marked improvement. The patient ultimately recovered.

It is especially under the thickness of the temporal muscle, itself swollen with extravasated blood, and the soft parts over it bruised and tender, and thus interfering with the accuracy of diagnosis, that the existence of a depressed fracture must be remembered, when an altered mental condition, dulness, &c., and, if on the left side, aphasia, supervene some time after an injury. Traumatic cerebral abscess (p. 269). Suppuration between the bone and dura mater, which is considered in the next section. Cases of hæmorrhagic pachymeningitis. J. C. Munro reports (*Chicago Med. Recorder*, Dec., 1902) eleven cases of this condition, five of which were operated upon, and one of which

* Iced boracic acid dressings have been recommended in these cases, but are not reliable, aseptically, in the earlier stages of the wound. Leiter's coil and iced water, a layer of jaconet being placed between it and the usual dressings, is the best way of applying cold in these cases.

recovered after operation. He arrives at the following conclusions. "(1) Hæmorrhagic pachymeningitis is found in the insane and infants, but for the most part in men, not insane, after middle life. (2) Alcohol, syphilis, acute and wasting diseases, and trauma apparently bear some causative relation. (3) The symptoms are those of diffuse sub-dural hæmorrhage, coming on slowly, producing mental irritation, spasm and rigidity of the extremities, convulsions, and, later, paralysis, the sequence being more or less irregular. (4) The cranial nerves are not likely to be affected. (5) The treatment is surgical, and should be instituted as early in the disease as possible. (6) Without operative relief in cases with pressure symptoms, the prognosis is practically hopeless."

TREPHINING FOR PUS BETWEEN THE SKULL AND DURA MATER.

While the mode of using the trephine here will in no way differ from that already given, a few practical remarks will be made on this most important condition.

It is well known that operative interference here, while less frequent owing to the improvements of modern surgery, has also been less successful than it would appear to have been a hundred years ago, when Mr. Pott drew the attention of surgeons to the need of trephining when pus was present immediately beneath the skull. For while Mr. Pott, in his day, saved five out of eight of these cases in which he trephined, surgeons of later days, when they have trephined, have been usually baffled by the co-existence of pyæmia, owing to an infective osteo-myelitis and phlebitis of the veins of the diploë, or, if this ominous complication be absent, by finding the collection of pus not localised between the bone and dura mater, or, if so localised, combined with suppurative arachnitis also.

Mr. Holmes (*Treat. on Surg.*, first ed. p. 130) brings forward the following weighty statements: "Some years ago I published (*Brit. Med. Journ.*, Oct. 16, 1858) the experience of St. George's Hospital in this particular for seventeen years—1841 to 1857 inclusive. Eight cases occurred in which the trephine was applied for pus. The pus was found in every case, but all the patients died. Seven were examined after death, and in six of these unmistakable evidence of phlebitis in the sinuses of the brain and veins of the skull and of general pyæmia was discovered. In the seventh case the abscess reached the ventricles of the brain. There were eight other cases in which the trephine was not used, and where matter was found above the dura mater, but it was not limited to this situation in any of these cases, nor would adequate exit have been procured for it by the trephine. In nine other cases there had been intracranial suppuration, but the matter was diffused among the membranes or in the substance of the brain, and lay entirely below the dura mater."

The above most gloomy picture of what has been usually met with only serves, I think, to confirm the opinion given below (p. 258), that the only hope for these cases is early exploration, to treat them, in short, more like cases of acute periostitis and osteo-myelitis elsewhere than has hitherto been the case.

When it is remembered that pus does not form between the bone and dura mater without a previous stage of infective osteitis and phlebitis of the veins of the diploë, it will be readily understood how easily, if the wound be contaminated, infective osteo-myelitis and phlebitis, with the inevitable result of pyæmia, will follow.

Indications of the Formation of Pus between the Bone and Dura Mater; Question of Trephining.—History of a head injury with damage of some kind to the outer table. Thus there is often a scalp wound exposing the pericranium, often opening this up at one or two points, perhaps small and not seen at the time; occasionally the bone itself is laid bare by the injury. Either now or later on, the wound becomes infected. After a varying period, usually in the course of the second week after the injury (during which period definite symptoms are often absent), headache, fretfulness, nausea, or vomiting set in, gradually followed by drowsiness, delirium, twitchings, convulsions, paralysis, coma, and death.

This onrush of symptoms about the eighth or tenth day may be accompanied by evidence of pyæmia—viz., rigors followed by sweating, a jactitating temperature, progressive emaciation, and affections of viscera and joints, amongst which pleuro-pneumonia is one of the most frequent and grave.

The surgeon who is watching a case of this kind, and who is also not unmindful of what has happened and what is liable to be going on—the injury to the pericranium and bone, the osteitis and osteo-myelitis with plugging of the diploic veins, the extension to the inner table, the formation between the bone and dura mater of lymph ready to suppurate, this deep-seated inflammation being only too ready to extend to the arachnoid and thus become a diffused meningitis—will find it a matter of much difficulty to answer the questions, How far has the mischief gone? Is the case a hopeless one? If the intracranial collection of pus be a localised one and uncomplicated, well-marked hemiplegia and the absence of pyæmic systems will call hopefully for trephining. On the other hand, paralysis, indistinct or complete, epileptiform convulsions, extreme irritability, and, especially, any evidence of involvement of nerves at the base, will all point to that form of meningitis which will show itself as a diffuse layer of pus and lymph over one side of the arachnoid.

Equally pointing to a fatal issue will be the symptoms of pyæmia already alluded to, and needing no further mention here.

What is to be done in these cases? Where the evidence of meningitis is undoubted, of some days' standing, where the hemiplegia has been little marked, or where it is replaced by paraplegia, general convulsions, and other unfavourable signs, no surgeon will be wise in trephining.

Should evidence of co-existing pyæmia be looked upon as equally hopeless and equally negating the use of the trephine? I scarcely think so. Every surgeon knows that, although pyæmia is usually fatal, it, very occasionally, ends favourably. Again, in treating pyæmia resulting from periostitis and osteo-myelitis elsewhere, we are not deterred from making free incisions and exploring the bone.

The right treatment of these cases must, of course, be really preventive—i.e., every scalp wound should be rendered aseptic and

so from the very first, however slight it seems to be. But, as this precaution is not always taken, and is occasionally impossible, the condition of the pericranium and bone should be explored earlier, at the very first warning of danger. Instead of treating such a case as a special result of a head injury, and waiting for evidence of pus between the bone and dura mater, we should, I think, deal with it as we do with periostitis and osteitis elsewhere; that is to say, that, in cases of this kind where there is reason to believe that the bone has been injured, especially if there be any doubt as to the condition of the wound throughout, the surgeon should, on the first appearance of malaise, irritability, headache, nausea, chilliness, explore the wound. Any granulations here present will very likely be at a standstill. A piece of bone will probably be bare and perhaps soft, the pericranium infiltrated and separating. The whole area of bone which is affected should be explored. This is done by removing the outer table and exposing the diploë with a trephine, Hoffmann's forceps and gouge. Wherever infiltration with pus or undue reddening is present; the diseased condition must be followed up. The state of the dura mater must be ascertained in every case where pus or lymph is present; the whole thickness of the bone lying over the diseased membrane must be removed with Hoffmann's forceps as widely as possible. Where the patient's condition admits of it and where this step is indicated by the symptoms, any of the sinuses that are adjacent to the area of operation and which can be reached should be explored, and, if infected, treated on the lines given at p. 314. In any case all infective granulation tissue must be removed and pure carbolic acid thoroughly applied. The possible co-existence of a cerebral abscess must not be forgotten (p. 250). Free drainage must be provided with iodoform gauze, and any sutures inserted should not be tied for a day or two. Boracic acid fomentations should be applied.

The above depends on the fixed conviction that trephining, in careful hands, and with due precautions, is not, in itself, a dangerous operation, and on the fact, which is beyond dispute, that, if these cases are left till hemiplegia announces the existence of intracranial pus, they will, too often, be left too long, as this waiting will give time for the onset of pyæmic infection, and for the arachnoid to be involved in the inflammation.

The operation of trephining here will in no way differ from that already described. Pus welling up from the diploic cancelli, or a fetid condition of these, is ominously suggestive of impending pyæmia. If such a condition be present, the bone should be freely removed, and disinfected as far as possible; but, from the probable extension of thrombi to the sinuses, the outlook is a very dark one. If pus be present between the bone and dura mater, it must be thoroughly evacuated, and free drainage provided.* The condition of the dura mater should always be examined, whether pus be found superficial to it or no. If it pulsate freely and be natural in appearance and devoid of lymph, nothing more need be done. If, on the other

* In these cases, and, in fact, in any trephining cases where the discharges are infected a boracic acid fomentation frequently renewed, together with a dusting of sterilised iodoform, is preferable to dry dressings changed less frequently.

hand, it bulge into the trephine-hole devoid of pulsation, it should be punctured, this perhaps giving vent to a jet of purulent fluid from the arachnoid cavity. If the arachnoid is seen to be covered with lymph, this is of the gravest omen. A second trephine-crown may be removed at the most dependent part, the dura mater again opened here, and irrigation employed.

The following cases are good examples of this most dangerous condition of osteitis of the cranium and its sequelæ and complications :

The first case, reported by Mr. Hutchinson (*Clin. Surg.*, vol. i. p. 97), shows pyæmia prominent rather than arachnitis; the second (*loc. supra cit.*, p. 102), also Mr. Hutchinson's, shows the reverse condition—much arachnitis, and no general pyæmia infection. The third, one under my own care, shows both arachnitis and pyæmia combined. In all, pus was present between the bone and dura mater.

J. W., aged 10, on October 15 received a large lacerated scalp wound, a triangular flap of all the tissues of the scalp being torn up from the left parietal bone. The pericranium was not torn up, excepting, perhaps, at a few points. The boy was admitted into the London Hospital at once, the flap of the scalp adjusted, and for some time all went on perfectly well, the boy being kept in bed only for a day or two. Oct. 29.—While up and at dinner he was noticed to be cold and shivery. A very severe rigor followed. It was impossible to ascertain whether, for some days, he had had headache or not. In the wound the granulations were pale and glazed, and a small piece of dry, bare bone was exposed. During the next few days there were repeated rigors. Nov. 1.—He had now very decidedly the aspect of pneumonia, and the breathing, temperature, pulse, and cough confirmed this. Nov. 2.—He seemed better than the day before, the respiration being more easy. There is not the slightest sign of paralytic weakness. "Doubts have been expressed as to whether this boy is or is not the subject of pyæmia. He looks comfortable, excepting for the blueness of the lips, which is less than yesterday. That he is suffering from pneumonia all must admit, and that the pneumonia does not produce the usual train of symptoms (no rust-coloured sputum, no great dyspnoea, &c.). If there had been but a single rigor, it is very possible that it might have been indicative only of pneumonia, but their recurrence seems to me to denote pyæmia. This diagnosis is also favoured by the fact of his apparent improvement at times and great variations in condition." The wound was now secreting a very fair quantity of healthy pus. Its granulations were much better than they had been, and fairly florid. During the next three days the thoracic symptoms increased. He emaciated rapidly. Consciousness was perfect to the last, and he had neither paralysis nor convulsions. All traces of granulation disappeared from the wound. He died November 7. There were very numerous pyæmic deposits in the lungs, liver, and spleen. Beneath the scalp wound was bare and greenish bone the size of a crown-piece. The edges of the wound and the pericranium were loose over a surface as large as the palm of the hand, comprising, in fact, nearly all the parietal bone. There was a recent scar in the scalp, crossing the vertex transversely, just above the lambdoid suture; the pericranium here was thickened and inflamed, and the bone on both sides of the sagittal suture here was green. On applying the trephine at this spot, dirty-green, fetid pus exuded on the inner surface of the bone. It must be observed that this portion of inflamed bone extended on each side of the sagittal suture, and that it was under, not an open wound, but a soundly healed one.

E. S., aged 10, was admitted, July 21, into the London Hospital with very extensive laceration of the scalp on the left side, laying bare the parietal bone. During the first few days he seemed to be doing well. July 26.—Bone as large as a crown-piece is exposed, white and dry, above the left ear. July 29.—A strong rigor. July 30.—Wound without granulations, looking glazed. July 31.—Very restless. Uses all his limbs at times, but the left ones much better than the right. Aug. 1.—The skull was trephined in the middle of the exposed bone, 2 inches directly above the left ear. The dura mater was covered with yellow lymph. It pulsated pretty freely. On cutting through it about a drachm of

thin, purulent fluid jetted out. The visceral arachnoid was seen to be covered with lymph. Aug. 2.—He still uses his left arm, but never his right hand. When the brain, which bulged, pulsating, into the wound, was pressed back, thin pus ran out in considerable quantity from the arachnoid cavity. His aspect was that of a patient in the very last stage of fever. Death took place on August 3. The bone around the trephine-aperture was dry and green. Everywhere on the left side the parietal arachnoid was concealed by a thick deposit of puro-lymph, whilst everywhere on the right side the membranes were perfectly free from deposit, polished and glistening. The superior longitudinal sinus contained puriform fluid. The skull at the seat of injury was discoloured over an extent almost as large as the palm of the hand; adjacent to it were other patches, greenish-yellow, opaque, and non-vascular. There were no pyæmic deposits in the lungs or in the viscera of the abdomen.

E. S., aged 40, slipped while getting off an omnibus, January 22, 1877, and was admitted into Guy's Hospital under Sir H. Howse's care with a scalp wound 4 inches long, exposing the right parietal bone. Owing to some oversight the wound was not dressed at first antiseptically, the discharge became offensive, and erysipelas of the scalp setting in, she was transferred to my care on February 1.—At this time almost the entire right parietal bone was exposed, owing to sloughing of the pericranium. Incisions were made where needful, drainage-tubes introduced, and in a few days the erysipelas had subsided and the wound was sweet. Feb. 11.—She had a rigor for the first time. Feb. 13.—There was some paralysis of the left side of the face and the left limbs. The temperature was 104°. Feb. 15.—The hemiplegia becoming more marked, I trephined through the exposed bone, about 1 inch above the right parietal eminence. Pus was met with in the diploic cancelli. On removing the crown of bone, an ounce of thick, foul, greenish pus welled up. The inner surface of the bone was very rough, the dura mater which corresponded to it being covered with velvety granulations. As the dura mater did not pulsate, it was punctured, but without result. The patient became more conscious after the operation, but soon lapsed again into a semi-comatose state. Convulsive seizures of all the limbs, with twitchings of both sides of the face, then set in, and continued till the patient's death on February 17. The parietal bone was found to be dying for a considerable area, the diploë being green and offensive. The pus seemed all removed from the dura mater, but there was suppurative arachnitis over the right hemisphere, reaching up to the falx in one direction and the base in the other, but stopping short of each. There were numerous pyæmic abscesses in the lungs and liver.

In the following case Sir W. Macewen (*Pyogenic Diseases of the Brain and Spinal Cord*, p. 289) was more fortunate. The case was one of intracranial extra-dural suppuration with pachymeningitis, exhibiting "Pott's puffy tumour," and originating in infective bruising of the scalp and deeper tissues, but here the pachymeningitis was fortunately limited and pyæmia absent.

I. B., aged 45, received from the shaft of a cart a severe blow on the left side of the vertex, about an inch from the middle line. He was subsequently able to work for a week without feeling anything wrong except slight pain over the part. Later on he felt feverish, the pain, which was of a dull character, increased, and was accompanied by occasional sharp stabs over the vertex. He also had great headache and prostration. There was a distinct puffy tumour over the seat of the former injury. This swelling, the patient declared, came on three weeks after the accident, and after it formed he had some relief from the pain. The primary swelling from the bruising had subsided some weeks before the puffy swelling appeared. On incision the skull was found bare, a small quantity of semi-purulent exudation bathing the bone. The diploic tissue was filled with granulation tissue, which could be traced in small portions penetrating the bone, both through the external and almost through the internal table of the skull, which was dark in colour. Between the internal plate of the skull and the dura there was a considerable layer of freshly formed granulation tissue bathed in purulent exudation. The patient's symptoms quickly disappeared after the operation.

TREPHINING FOR MIDDLE MENINGEAL HÆMORRHAGE* (Fig. 107).

Indications.—When a patient, after receiving an injury to the head, has shown several of the symptoms given below.

It is noteworthy that the injury and amount of violence vary extremely. While most frequently serious, as in falls on the head, the violence may be extremely slight, as when a patient slips going downstairs and strikes the head against the wall, when a boy receives a blow from a cricket-ball, or when a child has a fall of 2 feet 6 inches out of a swing. From this the following conclusions follow naturally:—
(a) That in the cases of severer violence, laceration or contusion of the brain are, only too frequently, complications; (b) Where the violence has been slighter, either no fracture may be present, or, if one be present, it is often only a mere fissure, and may involve the internal table only. It is a point of practical importance that the slighter the injury the less likely are the soft parts to show any damage. This has led, in several cases, to the injury being overlooked.

i. *Interval of Consciousness or Lucidity.*—This interval between the stunning effects of the injury or concussion and the onset of compression from the effused blood varies, when present, in length from a few minutes to several hours. In about half the cases it is well marked. In a second class it is but little marked, and may easily be overlooked altogether. In a third and last set of cases this interval is never present at all, owing to (1) The presence of a very large hæmorrhage, producing compression symptoms; (2) Co-existing depression of bone; (3) Co-existing injury to the brain; (4) Drunkenness of the patient.

ii. *Condition of the Limbs as to Hemiplegia, Paralysis, Rigidity, &c.*—Hemiplegia, though well marked in a large proportion of cases, must not be looked upon as essential, and middle meningeal hæmorrhage must not be overlooked because hemiplegia is absent, ill marked, or replaced by some other condition of the limbs. At least, the following seven conditions of the limbs may be met with in middle meningeal hæmorrhage.

(a) Hemiplegia present and well marked, the leg or arm, and usually both, when taken up and let go, dropping like those of a corpse. This condition is present in probably one-third of the cases. It is noteworthy that occasionally the hemiplegia is on the same side as that injured, the extravasation taking place on the side opposite to that struck. Thus in a case of Kronlein's, while the contused wound was over the right parietal, the part struck in the fall downstairs, the artery was lacerated on the left side.

(β) Hemiplegia present, but little marked. In these cases, which are not uncommon, the extravasation may be overlooked. They fall into at least two divisions. In one the hemiplegia is little marked throughout, due, perhaps, to some power of accommodation on the part of the brain, or to the circulation remaining feeble owing to co-existing shock from the time of the injury to the moment of death.

* For fuller information on this most important subject, I may, perhaps, refer the reader to an article contributed to the *Guy's Hosp. Reports*, 1886, p. 147

In another group of cases the hemiplegia is ill marked because of brief duration, coming on as it does in these cases towards the close, together with coma, giving but little warning and leaving but short time for interference.

When there is any doubt as to the existence or degree of hemiplegia, the following tests should be carefully made use of: whether the patient resists on the surgeon attempting to move the limbs; the power of the grasp, if any; the result of a needle-prick; whether the patient moves either of his hands, or which of them, when the cornea is carefully touched, or the cilia gently pulled.

(7) Hemiplegia present, but temporary. A very rare condition, produced probably by the brain being able to accommodate itself to the blood.

(8) Monoplegia, or the paralysis more marked in one limb than the other. While a large hæmorrhage generally makes pressure upon all the motor area, von Bergmann and Kronlein point out that the opposite arm is the part affected first and most, the branches of the artery having become quite small by the time they reach the centre for the leg.

(c) General paralysis. Another rare condition, the existence of which may be explained by a very large clot—e.g., on the left side, rapidly effused and making pressure through the left side of the brain, upon the right as well—or by co-existing extravasation into the brain substance itself.

(c) Absence of any paralysis. A very rare condition, and one which is, perhaps, due to the blood effused from the middle meningeal artery, finding its way through a fracture in the skull, beneath the scalp. (See footnote, p. 263.) Another explanation may be that the clot is posterior to the motor area, of the rarer occipito-parietal, and not the more frequent temporo-parietal variety (p. 264).

(7) Limbs rigid, convulsed, or twitching. It is only too probable here that, in addition to middle meningeal extravasation, contusion or laceration of the brain substance will be found at more spots than one.

iii. *Condition of the Pupils.*—Whilst this may be various, there are at least three conditions which are most important:

(a) If the pupils are natural as regards reaction to light, the compression of the brain is probably recoverable if trephining be immediately performed. Further, it is more likely to be a case of compression only of the brain, without other injury.

(β) If the pupils are insensitive, often at the same time dilated, the compression is probably extreme, and, while trephining is urgently called for, it is less likely that in these cases the brain will recover itself after removal of the clot.

(γ) If one pupil is found widely dilated, the other being natural or contracted in size, and if the dilatation be present on the side of the artery injured, in other words, opposite to the side of the body which is paralysed, it is a rare but most valuable sign, the explanation of which we owe to Mr. Hutchinson (*Lond. Hosp. Rep.*, 1867, vol. iv. p. 29).

Taken with other evidence of middle meningeal extravasation, the condition of the pupil points to a large clot, reaching the base and pressing forwards upon the sphenoidal lobe.

compressing the third nerve. But it is a rare condition. The behaviour of the pupils is very variable.

iv. *The Pulse*.—This will vary according as the case is one of well-marked, uncomplicated extravasation, or complicated with contusion or laceration of the brain; and, if the concussion stage has been severe, according to the degree to which the heart has recovered from this.

In well-marked uncomplicated compression the pulse will be slower than normal—*e.g.*, 66, 52 and still falling, 42, and usually somewhat full and labouring. If, later, a pulse which has been typically slow becomes very rapid it means that the final stage of paralysis of the vagus has set in, and that a fatal termination is imminent.

v. *Coma, or Unconsciousness*.—With regard to this, the following points should be borne in mind:

(a) The degree of unconsciousness will vary with the size of the branch injured, and the rapidity with which the blood is effused. Where the effusion is rapid and the compression great, the coma may be as deep and complete as in apoplexy. But, in other cases, it will be found that though the coma is apparently deep, this is not really so; thus the patient may moan constantly, or may move his limbs feebly when disturbed.

(β) The commencing coma may be taken for natural sleep, or drunkenness, in which conditions the patient may be allowed to lie till it is too late.

(γ) In a few cases the onset of the coma is deferred till late: its onset is here sudden, its course rapid, and it generally ends in death.

vi. *Respiration*.—This, in well-marked cases, is often stertorous and somewhat slow. In cases where stertor has not supervened to call attention to the existence of compression, other and still graver alterations in the breathing may be present, alterations which are warnings that the end is not far off, and that, in the case of intended trephining, there is no time to lose—*viz.*, catchy, short respirations, cyanosis, and gasping, irregular breathing, ceasing for intervals of ten or fifteen seconds, and then repeated.

vii. *State of the Scalp*.—When the history is deficient, or when the signs of compression are not well marked, ecchymosis or contusion of the parietal and temporal regions, giving rise to a pulpy or puffy feel, are of great value. This condition will be especially marked when the hæmorrhage from the middle meningeal artery is finding its way through some fracture into the tissues of the scalp.*

Treatment.—Early trephining should be performed as follows:—The scalp should be shaved widely, for the liberal application of ice, later on, if needful. No anæsthetic should be given if the patient is unconscious, or the respiration failing. If any be employed the greatest care must be taken on account of the risk of vomiting and aspiration-

* There is a good specimen of this in St. George's Hospital Museum, Series No. 4, figured by Mr. Holmes in his *Surgery*, fourth ed. p. 140, Fig. 39. It shows the parietal bone of a child, in which a gaping fissure crosses the middle meningeal artery, producing extravasation inside the skull, and still more externally. I have trephined a similar case. Here, during the half-hour which elapsed between the fracture and operation, a distinctly increasing swelling was noticed in the scalp

pneumonia. Von Bergmann alludes to the frequency with which this form of pneumonia proves fatal, in patients who have been deeply comatose, even some days after trephining has been successfully employed. The head being supported on sand-bags or a firm pillow, the middle meningeal area on the side which is bruised, and on the side opposite to the hemiplegia, is explored by turning up a semilunar flap, the centre of which is $1\frac{1}{2}$ inch behind the external angular process, and 1 inch above the zygoma—roughly speaking, two fingers' breadth above the zygoma, and about the same behind the external angular process (Fig. 125, p. 333). Kronlein (*Deutsch. Zeitschr. f. Chir.*, Bd. xxiii. Hft. 3 u. 4, March, 1886), distinguishes, according to the point of

FIG. 107.



Middle meningeal hæmorrhage with extensive fracture of the skull. Prep. 1593⁶¹, Guy's Hospital Museum. From the severity of the fracture, which involves both vault and base, such a case gives very little hope.

rupture, three hæmatomata—an anterior, fronto-temporal; middle, temporo-parietal; and posterior, or parieto-occipital. He advises trephining first at the usual place; if no hæmatoma be found here, a second perforation should be made further back, a little above and behind the ear, or, more accurately, at the inter-section of a line drawn backwards from the upper margin of the orbit with a vertical one carried up directly behind the mastoid process. Enlargement of either of these openings will enable the surgeon to deal with a middle or parieto-temporal hæmatoma. The brisk hæmorrhage which takes place from the scalp will be best arrested by applying Spencer Well forceps to the bleeding points, the forceps thus not only arrest hæmorrhage, but acting as retractors also. The pericranium is then carefully separated, and any fissure or fracture looked for on the bone. Whether one be found or no, a crown of bone is next removed with

full-sized trephine. When this has exposed the clot,* hæmorrhage may still be going on, warning of which will, perhaps, be given by the pulsation of the clot. This having been removed by a small lithotomy-scoop, one of Volkmann's spoons, the handle of a small teaspoon, or, if soft, better by irrigation, the hæmorrhage may cease, or it may continue profusely, welling up from a point quite out of reach. In such cases, the surgeon may, after saving his patient from the dangers of compression, have to face those of most serious hæmorrhage. In such a contingency, much will depend on the accessibility of the bleeding point, whether it is in the wall of the skull, or in the foramen in the base; the following steps may be made use of—a good light is essential, and an electric lamp the best: (1) Ligature of the artery, a second trephine opening being made below if needful, and the intervening bone chipped away; (2) Crushing together with forceps the edge of the bone from which the bleeding comes; (3) Under-running the artery in the dura mater with a fine curved needle; (4) The use of Horsley's wax (carbolic acid one part, oil two parts, wax seven parts); (5) If the bleeding spot is found by the aid of a pointed probe to lie in a distinct bony canal, the hæmorrhage may be arrested by plugging this canal with a tiny boiled and aseptic wooden peg;† (6) Forcippressure by means of a pair of Spencer Wells's forceps left *in situ* for twelve hours; (7) Pressure by suturing the edges of the wound,‡ first firmly plugged with tampons of iodoform gauze wrung out of 1 in 20 carbolic acid lotion, aided by digital pressure on the common carotid; (8) The above means failing, which is unlikely, ligature of the external or common carotid had better be resorted to.§ If such a step be really needful,

* Perhaps another crown must be removed for this. Thus, in one case, when trephining over the trunk of the middle meningeal, I came down on the prolonged tail-like extremity of a huge clot, reaching far away upwards and backwards, and due to a branch being opened at some distance by a most extensive fissure.

† This was suggested by Sir T. Smith, and used successfully by Mr. Willett and Mr. H. Marsh, at St. Bartholomew's Hospital, in cases of hæmorrhage from the descending palatine artery (*Clin. Soc. Trans.*, vol. xi. p. 71).

‡ This can only be carried out when the edges of the wound are clean-cut, and also when the surgeon is able to see his patient at short intervals, or to leave him in competent hands; otherwise, if the hæmorrhage persist, this step may increase the risk of that compression which the operation had been intended to obviate.

§ Ligature of the common carotid, if preferred, is justified by a successful case recorded by Dr. Liddell (*Amer. Journ. Med. Sci.*, vol. lxxxi. p. 344), in which secondary hæmorrhage from the middle meningeal artery, three weeks after a shell-wound in the temporal region, was successfully arrested by ligature of the common carotid. If the patient's condition be very grave, ligature of the common and not the external carotid will generally be resorted to, as being more quickly done. The additional special risks of this operation are, however, well known. Recently (*Brit. Med. Journ.*, Dec. 31, 1904) Dr. E. L. Robinson, of Guernsey, reports another successful case with several points of interest. The patient, a woman æt. 20, had, in falling from a shop-counter, struck her head against a shelf. She had walked home, a quarter of a mile off, and there vomited blood.

an hour later, she suddenly became unconscious
t pupil. A fracture was found in the anterior
he base. The bone when trephined was
up into the opening as soon as this
he bleeding—apparently the opening
" compression of the right carotid

a temporary closure of the common carotid (*q.r.*) will perhaps suffice. It is always to be remembered that local hæmostasis is greatly to be preferred, and that, of the methods given above, ligature of the middle meningeal artery itself is the safest.

Dr. Shepherd, of Montreal, records (*Brit. Med. Journ.*, 1896, vol. i. p. 905) an instructive case of middle meningeal hæmorrhage in which ligature of the common carotid was successfully resorted to. That the hæmorrhage was not severe at first, and pressure symptoms from the slowly spreading clot were not marked until the day after the accident, is explained, in Dr. Shepherd's opinion, by the fact that the rupture of the artery was low down, where the dura mater was closely attached to the base of the skull, and where it needed considerable force to separate it from the bone. In many cases of middle meningeal hæmorrhage the artery is injured higher up, and a clot more readily forms where the dura mater is not so closely adherent to the bone.

A large and very thick clot having been exposed by the removal of two trephine-crowns in the line of a fissured fracture in the anterior part of the left parietal bone, the empty meningeal artery could be seen ramifying on the dura mater, while blood was freely welling up from below. The incision was extended down to the zygoma, the temporal muscle and periosteum pulled aside, and a piece of bone 2 inches wide by 3 inches long chiselled away, in the hope of reaching the bleeding point. After a large amount of clot had been removed, there was furious bleeding from below. The brain and its membrane were held aside with broad retractors, and it was seen that the fracture ran through the foramen spinosum, and then across the body of the sphenoid. The artery was evidently torn in the foramen. It was decided to tie the common carotid. This immediately checked the free hæmorrhage, though venous oozing continued. All the blood clot having been washed out, the space at the base of the skull was packed with moist iodoform gauze, one end of this being brought out at the lower end of the wound. The patient soon recovered consciousness. Two days later, while the gauze was being carefully removed, "there was a tremendous spurt of blood" as the last piece came away. The wound was therefore again packed quickly with iodoform gauze, which arrested the hæmorrhage. Three days after, the patient had a chill, a temperature of 102.5°, and paralysis of the left side, and motor aphasia set in. These gradually disappeared in another three days, and the gauze was cautiously removed, the last piece without any bleeding, ten days after the date of the second plugging. The patient made an excellent recovery.

Dr. Shepherd considered that the paralysis and aphasia were due to the compression effected by the large quantity of firmly packed iodoform gauze, and not to ligature of the carotid, for these signs came on only after the second packing and were very temporary in duration. The compression would have been rendered still greater when the gauze became soaked with blood. Dr. Shepherd resorted to ligature of the common carotid instead of plugging the foramen, because this might have separated the fracture in the base of the skull.

As in all operations on the head and brain, where the patient's

and direct pressure with cyanide gauze soaked in adrenalin solution, the right common carotid was tied. This was successful at once. As the patient came round from the anæsthetic it was seen that the hemiplegia had disappeared. Save for rather tardy disappearance of the paralysis of the third nerve the recovery was uneventful. Two months later the patient was "absolutely well." Not the least interesting point in this case is the fact that, as far as the report goes, the clot, which must have been a large one, was removed to a very limited extent.

condition is a grave one, infusion of saline fluid (p. 140) should be resorted to when the artery has been secured.

How far the surgeon should remain satisfied with partial removal of the clot, or proceed to remove the skull, and then the blood, more extensively, must depend on the surgeon's surroundings, the amount of skilled help which he can command, but chiefly on the state of the patient, the size of the clot, and whether the depression in the dura mater begins quickly to pulsate and to rise up. If these last points are in doubt, there should be no hesitation, the condition of the patient admitting of it, in removing more bone (p. 362), and any clot which seems firm and dense, till all cause of depression in the membrane is removed.

Prognosis.—With reference to this point, I may quote the following remarks from my paper in the *Guy's Hospital Reports*, vol. xliii.:

"The chief points on which this depends are, whether the middle meningeal extravasation is probably complicated with such injuries as extensive fractures and brain injury, and, secondly, upon the date of trephining, and whether, at this time, the brain recovers itself quickly or not. With regard to the former, or the existence of complications, the surgeon will, if asked to state the probable result, base his opinion on the history of the case, the severity of the violence, *e.g.*, height of fall, whether any interval of lucidity has been present, and, if so, for how long and how far this has been well marked, how far the symptoms of compression, well-defined hemiplegia, the falling pulse, the stertorous breathing, &c., are present or replaced by, or complicated with, those symptoms which are believed to point rather to laceration or contusion of the brain and its membranes—viz., restlessness, convulsive movements or twitchings, pulse quick and sharp, and other evidence of pyrexia, which show that inflammation of the brain has probably supervened upon the injury to its substance."

The seventy cases on which the above paper was based appeared to fall into the three following groups:

A. *The Most Hopeful Cases for Trephining.*—Violence comparatively slight; laceration of middle meningeal artery or its branches; fracture of skull, if present, slight and localised to one side of skull, *i.e.*, not implicating the base; compression present, but little or no contusion or laceration of brain. Twenty-seven cases.

B. *Less Hopeful Cases.*—Violence greater; laceration of middle meningeal or its branches; fracture implicating middle fossa; some injury to brain, but this only trivial. Twenty cases.

C. *Cases probably Hopeless from the First.*—Violence very great; laceration of middle meningeal or its branches; fracture of skull extensive, perhaps implicating several bones and sutures both in the vault and base; injury to brain very severe. Twenty-three cases.

Sub-dural Hæmorrhage.—This obscure and difficult subject has recently had much light thrown upon it by a most elaborate and helpful paper by W. H. F. Fen, M.S. (*Guy's Hosp. Rep.*, vol. lix.) The diff. Sub-dural hæmorrhage, intracranial suppur. sy, cerebral hæmorrhage and men. aterly way. Full allowance is

often be present, and while upon (1) the long duration

of lucid or latent intervals, as in the case given below; (2) the presence of a scalp wound, a bruise, recent or remote; (3) the existence of Hutchinson's pupil (*vide supra*, p. 262), which is, however, rarely present, he points out that as diagnosis will be always difficult and often impossible, the only treatment in these days of modern surgery is early trephining. The friends of the patient should be warned that while this step is the only safe treatment where sub-dural hæmorrhage is present, it will fail when severe laceration of the brain is present as well, and also in those cases where it has been impossible to exclude such conditions as idiopathic epilepsy or uræmia. The following points of practical importance are brought out by Mr. Bowen in his paper. (a) No fracture may be present in these cases of sub-dural hæmorrhage. Operators who may be inclined on exploring a case to close the wound because the bones are found uninjured, should bear the above in mind. (b) If on opening the dura at more than one place, no clot is found and the brain bulges through, pulsating, the following possibilities must be borne in mind. (1) The diagnosis may be wrong and an intra-cerebral abscess may be present. If this is excluded, and if the passage of a curved director into the arachnoid cavity for the purpose of exploring neighbouring areas proves negative, the opposite side of the skull should be trephined and a careful search made there. (2) As in the case of middle meningeal hæmorrhage, it may be a case of extravasation from *contre-coup*, or the case may be one of those very rare ones in which the motor fibres have not crossed. (3) Where sub-dural hæmorrhage is present, tenseness and non-pulsation of the dura mater are far more valuable than the colour of this membrane. "If colour be relied upon, two conditions at least may lead to error, one being that the compressing agent is not always blood, but may be blood and serum, or serum alone, when there will be no discolouration, notwithstanding the presence of pronounced compression; the other that a thin layer of blood over the surface of the brain, associated with severe contusion, yet incapable of compression, may cause discolouration, and this may also appear to be present when merely caused by the very distended veins on the surface of the brain pressed against the membrane." (4) With regard to the method of removal of the clot there is nothing to be added to the account given at p. 265. (5) Hæmorrhage may be difficult to stop and may recur dangerously. In such cases it is possible that a sinus has been opened by a fracture running into the base. Cerebral arteries and veins have required ligature. (6) As to the advisability of drainage no rule can be laid down. Only when it is certain that all clot has been removed, and that the field of operation is sterile, should the wound be entirely closed. Each case must be treated according to the special conditions found. The following case under the care of the late Mr. H. W. Allingham (*Clin. Soc. Trans.*, vol. xxii. p. 220; *Brit. Med. Journ.*, vol. i. 1889, p. 887) is a most interesting one, the bleeding having come, apparently, from a laceration of the frontal lobe. The length of the "latent" interval will be noted.

A man, aged 40, was admitted into the Great Northern Hospital, December 7, having fallen off a tramcar when half-drunk. He complained of pain in the left shoulder; there was no evidence of injury to the head. The next four days the patient was very drowsy, and irritable when disturbed. There was no paralysis. December 13, the patient was

seized with convulsions. These began in the muscles of the left side of the face, the mouth being drawn up, and the eyelids moved in clonic spasm. The muscles of the neck were next affected, and subsequently the left arm and leg passed into a state of clonic spasm. The breathing was stertorous. The tongue was not bitten. Chloroform having been given, a curved incision was made from the right external angular to the mastoid process. A large flap having been turned down, a crown of bone was removed over the right fissure of Rolando—i.e., about $2\frac{1}{2}$ inches behind and $1\frac{1}{2}$ above the external angle of the orbit. The posterior branch of the middle meningeal ran across the dura mater exposed. This membrane did not pulsate, and appeared to show a black mass beneath it; the artery being secured, the dura mater was incised and a large black clot exposed. About 3 oz. of this having been removed, partly by irrigation, a large cavity could be felt as far as the finger could reach; the brain appeared to be much lacerated over the frontal lobe. The patient ultimately made a good recovery.

TREPHINING AND EXPLORATION OF CEREBRAL ABSCESS DUE TO INJURY.

Indications for Exploring; Symptoms and Diagnosis of Traumatic Cerebral Abscess.—Many of these are given at somewhat fuller length in reference to that form of cerebral abscess which, as one of the results of otitis media, is discussed at p. 305. To begin with, there is often the history of an injury.* This may have been a stab with a knife (p. 250), a graze of the head with brief concussion, a fracture, especially a compound one associated with an infected hernia cerebri, a blow with a stone, a glancing bullet, &c. Dr. Carson, of St. Louis, records (*New York Med. Journ.* Apr. 27, 1905), a case in which an abscess of the Rolandic area followed the ordinarily trivial bite of a woodtick, the infection reaching the brain through some of the emissary veins. The abscess had been opened and apparently healed. When Dr. Carson opened the abscess two months after the injury, necrosis of the skull was present. The patient recovered, but with total blindness. Again the nasal fossæ must not be forgotten as shown by the case I mention at p. 311. Dr. Carson also mentions the case of a child where the infection, starting in a nasal catarrh the result of an injury, extended through the cribriform plate to the brain and formed an abscess which resulted in death. Often, but not always, follows a latent period devoid of brain symptoms, which may last from a few—e.g., four—days to three or four weeks or much longer.† This latent period is succeeded by brain

* But the help in the case which the history of an injury gives is not always present, and this is an indication for always examining for any wound or scar, and exploring it, however unimportant it may seem to be, in these cases. Thus, in the following case (Hulke, *Syst. of Surg.*, vol. i. p. 626), the necrosis might have been overlooked, and the fit and rigidity put down to another cause. A middle-aged woman, having fallen down in a fit, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On her right temple was a small festering wound, leading to necrosed bone. On perforating this with a trephine, pus was forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. A large abscess-cavity was found in the anterior lobe of the right cerebral hemisphere.

† As in M. Dupuytren's and Prof. Nancréde's cases at p. 250; so, too, in a case of Mr. Hulke's, alluded to in a footnote, p. 270, the patient, an errand-boy, continued to work for seven weeks after the injury, more or less headache being present all the time, retch
ming on.

symptoms increasing in severity and going on to those of compression—viz., headache felt over the side injured, but not necessarily most intense at the injured spot; nausea or vomiting; some pyrexia, although the temperature usually rises slowly, if it rises above normal at all.*

Other symptoms are mental dulness (the answers long delayed, but intelligent when they come), a slow pulse, perhaps rigors, progressive emaciation, perhaps accompanied by vomiting. Whether local nerve symptoms—*e.g.*, disturbances of sensation and motion—are present must depend on the position of the abscess. If the injury has been over the motor area (Figs. 123 to 128) nerve symptoms may be clearly marked; but if over the anterior part of the frontal or temporo-sphenoidal† lobes, they may be entirely absent. Thus hemiplegia‡, a paralysis limited—*e.g.*, of upper limb, and, later on, gradually increasing,—epileptic seizures, spasms, spastic rigidity, all have been met with, but must by no means be relied upon; and even when paralysis is present it may escape observation, as when there is slight paralysis of the muscles of the lower half of the left side of the face, and some loss of power in the left hand and arm, but only temporary.§ Here, as in otitis media, there is but one rule, and that is, that in all cases where an abscess of the

* On this and other points I would refer my readers to p. 302. Prof. Nancrede (*loc. supra cit.*, p. 95) writes thus:—"I believe that an abscess involving the cerebral tissue alone will be accompanied, in most cases, by a subnormal or, at least, a normal temperature. Where a high temperature is noted, either the pus collection is a localised suppurative arachnitis limited by adhesions, or there is a meningitis in addition to the abscess." Prof. Nancrede quotes briefly a case recorded by Dr. H. L. Brown (*Bost. Med. and Surg. Journ.*, Dec. 29, 1881, p. 610) in which the temperature was 97° for eleven days. More rarely, the temperature shows fluctuations, as in a case of Dr. Burney Yeo (*Brit. Med. Journ.*, 1879, vol. ii. p. 84). More rarely still, the temperature continues high throughout.

† With regard to the large collections of pus often found here, Dr. Yeo (*loc. supra cit.*, p. 885) quotes as follows from Huguenin (Ziemssen's *Cyclopædia*, vol. xii.):—"The difficulty of diagnosis is increased by the circumstance that no bands of fibres, which are direct conductors of sensibility or motion," pass through this lobe; and, therefore, an abscess here "may attain a considerable size, and may cause general symptoms of compression, before any distinct symptom of local disease arouses the suspicion of a localised affection of the brain."

‡ Mr. Hulke, in relating the case of a boy which he brought before the Medico-Chirurgical Society, March 11, 1879, laid stress on the fact that hemiplegia occurring some time after an injury to the head was significant of disease in the brain itself rather than of arachnitis.

§ The value of accurately noting symptoms which, though of but brief duration, may be very important guides in treatment, is well shown by a case of Sir W. Macewen's (*Lancet*, 1881, vol. ii. p. 582). A boy, aged 11, was admitted into the Glasgow Royal Infirmary, two weeks after a fall upon his head, with a partially healed wound and bare bone over the left eyebrow. A week later he had a rigor, considered to indicate the probable formation of pus. Five days later, or twenty-six days after the injury, the patient had a convulsion confined to the right side; when this had passed off, he was distinctly aphasic. The seat of the abscess now seemed to be the third left frontal convolution, and trephining was proposed. The friends, however, refused to permit this, as the patient had recovered consciousness, though they were warned that the improvement would be only temporary. Thirty hours later, the convulsions of the right side recurred, the temperature rose quickly from 101° to 104°, and the patient died before the operation could be performed. The situation of the abscess was verified after death.

brain *may* be present, exploration should be undertaken, and that this step should not be deferred.

For, the surgeon, who is watching what he believes to be a cerebral abscess, must always remember that after a period of latency, which may last weeks or more, acute symptoms may set in suddenly and quickly close in death.*

Operation of Trephining for Traumatic Cerebral Abscess.—As the fatality of cerebral abscess, if left to itself, is so high—90 to 100 per cent.—trephining is abundantly justified, but it must be conducted aseptically for fear of setting up suppurative meningitis and brain softening. The chief difficulty is, of course, hitting off the seat of the abscess, especially in cases where there are no definite nerve symptoms to guide, and where the history of the part of the head injured is indefinite also. To obviate the necessity of multiple trephining, Dr. Fenger and Dr. Lee, of Chicago, have recommended (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 78), as easier and safer, exploratory puncture and aspiration. This must be done methodically, with a needle, 4 inches long, set in a large-sized hypodermic syringe. The needle should not be too fine, and the gauge should be powerful enough to make sufficient suction, as a fine needle is readily plugged with brain substance. This may be easily taken for pus. The needle, sterilised, is pushed, through a trephine-hole, straight in, in a definite direction, for $\frac{1}{2}$ inch or 1 inch; the piston is then withdrawn a little, and, if no pus follows, the needle is pushed $\frac{1}{2}$ inch further, and the piston again withdrawn. The depth to which it will be permissible finally to push the needle will, of course, vary with the position of the trephine-opening and the direction of the puncture, the surgeon being guided by the anatomy of the brain. The punctures are to be repeated at intervals of $\frac{1}{2}$ inch or 1 inch, the utmost care being taken to push the needle in straight, and to avoid all lateral movements. The loss of resistance, and the sensation that the point moves in a cavity, are to be carefully watched for. If after a reasonable number of punctures, no pus is withdrawn, the operator may feel convinced that none is present. An abscess in the brain is usually as large as a walnut, often much larger. More details are given at p. 306.

Puncturing healthy brain tissue with a fine, perfectly aseptic needle can do but little mischief.

The needle should be kept as a guide till the abscess-cavity is definitely opened either by inserting a pair of Lister's sinus-forceps, or a sharp, straight bistoury. The abscess must be thoroughly drained and made to close from the bottom. From an experience of three successful cases, I have not found it so easy to keep a drainage-tube

* The sudden cessation of breathing in cerebral cases has been already noticed at pp. 242, 263. So, too, in a case which Mr. Gamgee brought before the Medico-Chirurgical Society, June 14, 1879. A boy, who had been trephined for suspected cerebral abscess, the pus not being found, suddenly ceased breathing the day after the operation. The patient, though apparently dead, having been partly revived by artificial respiration, the dura mater and brain were incised—a step which had not been taken before, as the former structure looked healthy, and did not bulge into the trephine-hole; pus welled up, and the child survived for a week. At the necropsy an abscess 2 inches long, and still containing an ounce of purulent fluid, was found in the right frontal lobe; the abscess had burst ^{trans-}orally, causing purulent meningitis. In other cases the sudden onset of grave ^{is} is due to the abscess rupturing into the lateral ventricle (p. 250).

securely in the abscess-cavity as it is to find this (p. 310). The abscess-cavity may be washed out with a lotion of biniodide of mercury (1 in 2000), or one of bichloride solution (1 in 4000); all the fluid injected should be withdrawn.

The following cases of traumatic cerebral abscess, in addition to those given at p. 250, and in the footnotes to pp. 269, 270, are good instances of the disease and also of its successful treatment:

A labourer, aged 60, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when headache, which he had had from the time of the accident, became very severe—so severe that his wife feared that he would go out of his mind. On admission the pulse was 56, and the temperature slightly below the normal. The patient's mind was unclouded. About one week later, in the night, he became insensible, and in the morning the right upper and lower limbs were found absolutely palsied as regards motion, and nearly so as regards sensation. When the arm or thigh was severely pinched, he gave scarce any sign of consciousness of it, but shrank slightly when the left limbs were pinched similarly. Two days later, spastic rigidity of the left arm supervened. A small disc of bone cut out beneath the bruised bone on the right temple appeared uninjured. The dura mater bulged up so tensely that pulsation could neither be seen nor felt; its exposed surface appeared healthy. A needle connected with an exhausting syringe was pushed through it to a depth of $1\frac{1}{4}$ inch. A brownish turbid fluid rose up into the receiver, and continued to flow after the needle was withdrawn. The minute opening was enlarged with a scalpel, and a considerable quantity of fluid escaped. The flaps, which had been reflected, were replaced, and the wound was very lightly dressed with a little boric charpie. An hour later he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation the charpie was wetted and discoloured by the fluid which continued to ooze, but the wound soon healed, and two months after the operation the patient appeared quite well. (Hulke, *Syst. of Surg.*, vol. i. p. 628.)

It is interesting to note in the following case that the hemiplegia which followed the operation was only transitory. It also shows that grave symptoms may be latent for as long as five months if a skull wound remains unhealed.

A child, aged $4\frac{1}{2}$, had sustained a severe compound fracture of the right frontal bone. The removal of some necrosed portions of bone led subsequently to a slight hernia cerebri. The sinus persisted, but the child seemed well in other respects, until about five months after the accident, when left-sided convulsions (chiefly of the muscles of the face and arm) came on, and an alarming condition rapidly developed. The sinus was opened up and a director passed for a distance of 1 inch into the right frontal lobe downwards and backwards. A free flow of fetid pus occurred, and after the cavity had been washed out with carbolic solution (1 in 40), a drainage-tube was inserted. The latter was removed at the end of a fortnight. Left hemiplegia followed the operation, but it passed off some twenty-four hours subsequently. Recovery was rapid and complete.

TREPHINING FOR EPILEPSY AND OTHER LATER RESULTS OF A CRANIAL INJURY.

This is one of the advances in cranial surgery, the results of which have not come up to the expectations formed of it. The operation—one of the most ancient in the history of surgery—after being almost abandoned for centuries, has been again taken up in the last seventeen years, with all the advantages of modern surgery, especially in those

cases where, after an injury, epileptiform convulsions beginning in the leg, arm, or face are due to lesions of the corresponding parts of the motor area. This form of convulsion forms a large part of the epilepsy which bears Dr. Hughlings Jackson's name. I fear that any candid inquirer, weighing, fairly, unsuccessful as well as successful cases, and attaching due importance to the facts that many of the former have not been published, and that most of the latter have been published prematurely as to final result—*i.e.*, before they have been submitted to the time-test—will come to the conclusion that the result of trephining for traumatic epilepsy is a disappointing one.

It will be worth while to go a little into detail with regard to the grounds which have led me to the following conclusions :

Results of Operation.—Later collections of cases, and (what is of paramount importance) keeping cases more carefully under after-observation, have shown that the operation for traumatic epilepsy has not come up to the expectations formed of it. Thus Prof. Agnew (*Trans. Amer. Surg. Assoc.*, 1891, vol. ix. p. 15) gives results in 57 cases operated upon at Philadelphia. Of these 57 cases, 4 died (a mortality of 8.77), 4 were cured, 4 were operated upon too recently to venture an opinion, 4 passed out of observation, 32 experienced temporary benefit, and 9 obtained no relief. Of the 4 reported as cured, Prof. Agnew is careful to point out that 2 had not been under observation longer than ten months, a period quite inadequate to allow us to speak with any confidence as to the final result. It is shown by cases quoted below one of Nancrede's (p. 275), and Benda's case (footnote, p. 276), over 3 years and 6 years had passed, respectively, before the relapses of epilepsy took place.

From the above statistics Prof. Agnew was of opinion that surgery would do but little for traumatic and Jacksonian epilepsy. He held that the treatment must be mainly preventive. "It is not saying too much to assume that surgery is responsible for the great majority of traumatic epileptics, and though this statement does not by any means criminate the surgeon of an early day . . . the doctrine that depressed fractures of the skull without symptoms required no operative interference I hold to be responsible for many, very many, of the unfortunate sequelæ of head injuries. However small may be the depression which follows a fracture of the cranium, save in one or two localities, it will encroach enough upon the dural nerves to cause more or less irritation; though insignificant at first and not at all recognisable to the consciousness of the patient, yet eventually that irritation will be propagated to the meninges, and later on to the cortex and brain ganglia, until finally the paroxysmal explosion occurs; and then, even when the initial lesion is removed, the slowly established habit, created by years of excitation, will remain as an ineradicable legacy. No amount of foresight can determine what happens to the inside of the skull, after an injury, by an inspection of its exterior surface. Whenever, therefore, the profession can accept the doctrine that all depressed fractures of the cranium, however slight the depression, and entirely independent of pressure symptoms, are proper subjects for trephining, then will traumatic epilepsy largely disappear from the list of surgical diseases."*

* Reference to the warning given at p. 246, that an injury to the head may cause a contusion of the brain and subsequent sclerotic degeneration, and thus epilepsy, without
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Dr. E. G. Mason, of New York, tabulates (*Med. News*, vol. i. 1896, p. 313) 70 cases in a paper which is especially valuable because he refuses to accept any cases as "cures" unless the patients have been under observation for three years, and have had no return of fits. Starting with this most sound and wise proviso, he finds 3 cases only (or 8.6 per cent.) can be accepted as cures; 6 (or 8.6 per cent) showed improvement of more than a year's duration; in 14 (20 per cent.) there was no improvement; in 3 cases death, due to the operation, followed (*vide infra*, Starr). In 38 cases (54.4 per cent.) the period of observation which had elapsed since the operation was not sufficient to justify a decided opinion being given, "though extravagant claims were made in not a few cases."

Another American authority, Dr. Sachs, Consulting Neurologist to Mount Sinai Hospital, New York, working with Dr. Gerster, Surgeon to the Hospital, after a wide experience, came to the same opinion some years ago, and, it is noteworthy, after further opportunities, abides by it. Publishing, fourteen years ago (*Amer. Journ. Med. Sci.*, Nov. 1892), the results of 9 cases, these authorities stated that the "prospects are rather gloomy," and that "the successful cases will probably be those in which there was some tangible organic lesion which has been removed at a very early period, or those cases in which, after injury to the skull, trephining has been done before the effect of the depression of the skull has resulted in the development of epilepsy." Writing again in the same journal, four years later (Oct. 1896), to record 9 other cases, Dr. Sachs and Dr. Gerster say that "the experience of later years has taught us that this statement was a just one, and that the views then expressed still hold good; but we have gradually been convinced that if the cases for operation are selected more carefully, and if the surgical technique is perfected, the prognosis need not be stated quite so gravely, and that it is possible not only to relieve many, but to cure some of the cases of epilepsy." A little later, as a result of most carefully prepared tables, in which the 19 cases are recorded, we are told: "If we were to attempt to give a purely statistical statement we might say that of the 19 cases here reported, 3 were cured, 2 greatly improved, 3 somewhat improved; while in 11 cases there was absolutely no improvement. These last 11 cases are equally valuable, however, in showing that partial epilepsies which have existed for a long number of years cannot be cured or improved by any operative procedure."

In 52 American cases collected by Dr. Starr (*loc. supra cit.*, p. 28), 13 being under his own observation, 13 were cured, 11 improved, 15 not improved, and 13 died. Here also, in several instances, the time that had elapsed between the operation and the date at which the case is reported is quite inadequate.

Starr (p. 112) says as to the result in these cases: "It is evident that in the majority there has been a failure to permanently cure epilepsy by operative interference. When we raise the question why the operation has failed, the obvious reply is, that the original condition which gave rise to the fits has not been removed. This is evident

any fracture or depression of the bone, however slight, will show that the above sanguine statement must be accepted with some reservation.

from a study of the pathological changes already enumerated. It is, of course, quite possible to elevate depressed bone, to remove a cyst, or to take away any mass of connective tissue or tumour which compresses the brain. But, on the other hand, it is useless to break up adhesions between the dura and pia or between pia and brain, because they will inevitably re-form after the operation. . . . Fine trabeculæ of connective tissue entering the cortex from the pia, and forming a dense scar tissue in and about the motor cells, give rise to an irritation which can only be removed by the excision of the mass. But excision of such a mass together with the brain, or excision of a softened mass of brain, is inevitably followed by a formation of a connective tissue cicatrix which, in turn, will act as an irritant. . . . I think the fact that the underlying organic brain disease producing the epilepsy cannot always be eradicated by an operation fully explains the failures which have been recorded by so many observers. . . . But when it is taken into consideration that in no case is it possible without an operation to determine the exact pathological condition present, and that a certain proportion of the pathological conditions are removable, it is evident that an operation, if not attended with danger, may be reasonably undertaken."

On account of the importance of the subject I give the most matured opinion of another American authority on the Surgery of the Head, Prof. Nancrede, of Michigan. The cases are three, and well reported (*Annals of Surgery*, 1896, vol. ii. p. 122). In all three a cortical centre was excised, in all three the fits recurred, though in one case two and a half years, and in another somewhat over three years, had elapsed since the operation: "The brief histories related, the remarks made, and the conclusions now to be given have seemed to me only worthy of attention because they are the results of the rather unfavourable experience of a former enthusiast for the removal of cortical centres in epilepsy, and give what is unusual, the closing results, though somewhat unsatisfactory, of cases reported by the operator himself. It is common enough to read of *cures* (?) a few weeks or months after operation, but rarely are the *relapses* recorded years later."

The following are the chief conclusions to which Prof. Nancrede has "somewhat reluctantly been forced":

"(1) Removal of the discharging lesion in cortical and Jacksonian epilepsy can only be regarded as palliative; the operation scar, in all instances thus far accessible to me, in time becoming a new source of irritation. (2) The earlier the operation is done after the disease becomes fully established, the longer will the immunity last; and it is possible that, if trephining is done very early, the operation may in a few instances prove curative, especially if any reliable method can be devised to lessen the extent of the inevitable adhesions between the brain and the membranes.* (3) Removal of the discharging lesion is imperatively demanded as a life saving measure in those rare cases where the intervals between the fits are so short that the paroxysms are practically continuous. (4) In all cases, especially those characterised by frequent paroxysm

to permit the early resumption

of work. Operation removes only one of the factors productive of epilepsy, but the ready response to stimuli still remains, and can only disappear, if ever, after a prolonged period; therefore careful avoidance of everything which can, either through the mind or body, excite sudden and severe cerebral congestion must be avoided for the longest possible period—for the remainder of life, if possible.*

But while it is authoritatively proved that the value of trephining for traumatic epilepsy has been greatly exaggerated, owing to many operations having been ill-advised, and also, what is less excusable, to premature reporting of "successes," it by no means follows that this operation is to be abandoned. It is to be employed on more careful and more scientific lines. We should be more careful in promising success save in cases of recent date, where there has not been time for the changes to occur which, as we have seen, must render recurrence of the convulsions after a time a matter almost of certainty. In other cases it will be only honest not to hold out much hope of cure, but to explain to the patient and his friends that the operation more or less must be uncertain; that its dangers are slight in experienced hands; that while cure in the truthful sense of the word is unlikely, some relief will almost certainly be granted in the number and severity of the fits; that as to any headache, &c., from which the patient suffers, it is impossible to state what the amount of relief will be till the parts have been explored; and, having said this, we shall be wise if we leave the decision in the hands of the patient or his friends.

For, as we know nothing of the actual causation of epilepsy in these cases, so we must rest uncertain as to the relief which a trephine-opening on wide lines may give. If headache or optic neuritis are present, these will be relieved. As to convulsions, we may hope that, in cases which are not of too long standing, the relief to tension may help towards recovery the impaired vitality of cells so delicately constituted as those of the brain. In other cases the opening may allow of the intracranial circulation undergoing fluctuations, to which it is inevitably exposed, without the unstable cortical centres becoming congested and irritated and prone to explosions, as would otherwise be the case.

J. Chalmers Da Costa (*Medicine*, February, 1904) writes that he is in entire agreement with the last two paragraphs which I wrote in 1903. His conclusions are as follows: "Operations for epilepsy are distinctly disappointing and rarely curative; and are indicated in only a small proportion of cases. They frequently produce temporary benefit. They may save life, but they are not entirely free from danger, and occasionally leave the patient worse than before.† The mortality,

* The views of the American authorities on the results of surgical treatment of epilepsy have been quite borne out by the experience of Continental surgeons—viz., Bergmann (*Berl. klin. Woch.*, April 22, 1895), Eulenburg (*ibid.*, April 15, 1895), Solly (*Charité Annal. Jahrgang*, xx.). For a more recent expression of German opinion the Proceedings of the German Surgical Congress of 1903, may be consulted (*Annals of Surgery*, Dec. 1903). The opinion of von Bergmann (*loc. supra cit.*) as to the permanent value of the operation is also unfavourable. He states that the case of Benda which was assumed to be cured after six years, has recently again become epileptic.

† *E.g.* when cortical centres have been extensively removed. On this subject the reader is referred to pp. 283, 375.

though small, is not inconsiderable. The actual number of complete recoveries is probably under 5 per cent."

Condition of the parts which may be met with during the operation, and which may have originally caused the epilepsy.

(1) **The Scalp.**—Shaving often reveals scars known or undiscovered. When operation was again resorted to in this disease, some years ago, it was hoped that tenderness of such scars would be a valuable guide and characteristic of cases to be benefited by operation. Thus, Mr. Walsham (*St. Bart. Hosp. Rep.*, 1883, vol. xix. p. 127) found that, of 82 cases, the scar or spot was sensitive, tender, or painful in 42. Pressure in some caused vertigo, convulsions, rigidity or spasmodic twitchings of certain groups of muscles.* Larger collections of cases have shown that these instances are fewer than was hoped, the share taken in epilepsy by tender scalp scars being a small one.† An instance of these rare cases may be found quoted by Dr. Agnew (*Trans. Amer. Surg. Assoc.*, vol. ix. pp. 16, 17), in which, in a patient operated on by Dr. T. S. Miller with success, a branch of the great occipital nerve was found caught in an old fracture. In 8 out of the 44 cases collected by Mr. Walsham a sinus was present leading down to bare bone.

(2) **The Periosteum.**—This may be found extremely thickened, and very closely adherent to the bone. Excess of vascularity may also be met with. Osteophytic deposits have not been observed.

(3) **The Skull.**—Lesions of all kinds have been present. Depressions, fractures, fissures, are common. From the inner table a spicule or exostosis ‡ may project inwards. With regard to these last conditions, it is very noteworthy that in one of the cases collected by

* It is especially in those cases in which pressure on a tender scar produces convulsive movements on the same side, that the surgeon may be content with removing the scar.

† Dr. T. H. Manley, of New York (*Journ. Amer. Med. Assoc.*, vol. ii. 1895, p. 1017), gives the following warning with regard to these scars: "In many who come to us with these scars on their scalps, no doubt, if we instituted a searching enquiry, we should find, in some of them at least, that they were produced by a fall in an epileptic seizure."

‡ The term exostosis is sometimes applied to the depressed bone; this, when circumscribed and osteophytic, is easily dealt with. An allied condition, rarer, and one much more difficult to deal with, is described by Dr. Echeverria (*Arch. Gén. de Méd.*, 1878, t. ii. p. 533). A conical, irregular projection of bone, measuring $2 \times 2\frac{1}{2}$ inches, here compressed the dura mater and brain, being situated very close to the superior longitudinal sinus, just to the left of the occipital protuberance. In trephining, the crown entered into this exostosis, the removal of it proving most laborious, the operation lasting three and a half hours. The patient recovered. A case of Kochler's, of Berlin (*Deutsche Med. Woch.*, No. 46, 1889), illustrates a less localised condition. A sword-cut had injured the bone, without depression. Epileptic fits followed in six weeks. About a year later trephining was successfully performed. The dura mater was adherent, the bone much thickened and covered with thorn-like processes pressing on, but not perforating, the dura. Before deciding whether any diffuse thickening of the bone is really morbid the varying thickness of the skull in different parts must be remembered. Good illustrations of a blunt spicule on the inner table are given by Dr. Williamson and Mr. Jones (*Brit. Med. J.*, 1889, vol. i. p. 1017). In this case, six months after the operation the fits recurred. On trephining, a small spicule of necrosed bone "projected from the inner table." In the last report, recovery was complete.

Mr. Walsham, though nothing was detected at the operation, a spicule was found, at the necropsy, not far from the trephine-hole, this pointing to the advisability of sweeping a probe carefully and with aseptic precautions so as to explore the parts at some distance from the circumference of the opening. Another point which is of great importance with regard to the indications for trephining as given by the state of the skull is this: several cases have been recorded which prove that it is not always safe in trephining for epilepsy to rely on the position of a fracture, unless that fracture coincides very closely with the spot selected for trephining from the character of the fit. Thus, in two cases related by Dr. Starr (*loc. supra cit.*, pp. 30, 32), depressed fractures existed, epileptic attacks had developed subsequently to them, but the fit, which, in both patients, began in the arm, indicated disease in the middle third of the motor area, while the position of the fracture was upwards of two inches away from this spot.* In another case, where the surgical indication or position of the fracture was put aside in favour of the medical one, or the evidence given by the fits, the latter proved to be the correct one, as on raising the button of bone a splinter from the internal table was found penetrating the dura mater and brain, though at the spot selected there was no evidence of fracture.

(4) **The Membranes.**—Before opening the membranes the surgeon should remember that it is at this stage that danger begins. Aseptic trephining in experienced hands entails no risk, but it is another matter when the membranes are opened and the brain itself is interfered with. The risks of hæmorrhage, sudden cessation of breathing, shock, infection, hernia cerebri, have now to be faced. Both the dura and pia mater may be found much thickened, blended with each other and adherent to the cortex. In some cases they form respectively the outer and inner wall of a cyst.

(5) **The Brain.**—When pathological changes are present in the part explored, the cortex may be found compressed or indented, stained, sclerosed or softened. Cysts in the cortex, perhaps the result of old hæmorrhage, are not uncommon lesions,† and are amongst the most

* Such cases emphasise the need of sweeping a probe around the margins of the trephine-hole, so as to explore the neighbourhood thoroughly.

† The following are instances. In the first (Echeverria, *loc. supra cit.*, p. 535) an old hæmorrhage was present. The patient, aged 22, had, ten years before, fractured his right parietal bone. Epileptic fits began six months after the injury, and their increasing frequency was associated with an extreme degree of idiocy, the patient being, on admission, a mere automaton without intelligence or memory. On the seat of fracture being explored, a kind of pouch was found embracing an old blood clot. When this was turned out, the hæmorrhage was so free as to require the actual canterly. The intellectual faculties were largely restored by the operation, and the fits were also much reduced in frequency. The death of the patient took place, nearly nine months later, from meningitis, apparently due to exposure to the sun. An autopsy showed that the clot-containing cavity was in connection with the meninges, and apparently continuous with one of the branches of the middle meningeal artery. In the second, a cyst was also the cause of the mischief. Thus (*Ann. of Surg.*, vol. iii. No. 6, p. 522; *Amer. Journ. Med. Sci.*, April, 1886), after a pistol-shot wound of the skull, about $\frac{3}{4}$ inch from the middle line, and $1\frac{1}{2}$ inch from the hairy scalp, aberration followed, culminating in marked insanity. On the depression in the forehead being explored by a crucial incision, an opening in the skull was discovered, closed by fibrous material. In the expectation of

hopeful for treatment. As cysts can rarely be removed, their lining membrane should be carefully curetted, wiped over with pure carbolic acid, lightly plugged with iodoform gauze, and drained, otherwise a fresh secretion of fluid and a recurrence of the symptoms is almost certain.* Any blood clot must be removed by curetting or carefully cut away. If old, it may resemble yellowish scar tissue. If the dura has been opened to get at it, the edges of this membrane must be drawn together with sutures, drainage being employed if needful.

Before cutting through thickened membranes, especially if adherent to the brain, the surgeon should remember the following case, which occurred in the experienced hands of Dr. Gerster himself:

The patient, æt. 17, had been operated on twice before. The epilepsy continuing and the patient being anxious for a third operation, an attempt was made to lessen the tension caused by a scar at the site of the first operation, over the left arm-centre. Cutting through this scar, the surgeon found an enormously thickened membrane between the dura and the scalp. In the attempts to separate adhesions and cut through thickened membrane, excessive hæmorrhage occurred, which it was impossible to check for some time. The patient did not recover from the shock of the operation, and died in collapse three days later.

Dr. Hamilton, of Chicago (*Amer. Jour. Med. Sci.*, 1894, vol. ii. p. 952), when exploring behind the right fissure of Rolando in a patient suffering from headache and blindness of the right eye after an injury, made use of the following manœuvre:

Finding the cranium and dura healthy, he opened the latter and passed in a loop of silver wire in different directions. On withdrawing it on one occasion a firm coagulum, measuring 3 centimetres in length, was found adherent to the wire. On the second day after the operation, convulsions and spasm appeared in the left arm, together with loss of consciousness. The wound having been opened up, clots were found pressing on the dura mater. These were removed. Vision was quickly restored, and the patient remained quite well a year later.

If nothing be found when the dura is opened, the surgeon may, before deciding to interfere with the brain itself, explore the neighbourhood of the wound within the dura with a blunt-pointed instrument, e.g., a female catheter, or a curved, flexible director, sterilised. By this means a clot or cyst, which would otherwise have been missed, may be detected, and dealt with by enlarging the opening.

But even when clots and cysts may seem to have been satisfactorily dealt with, and the fits cease at once, mischief in the brain may co-exist (especially if the case be one of long standing) and lead to their recurrence (*vide infra*).

The majority of lesions of the brain will, however, be found to be much less amenable to treatment. How varied they are is shown

finding an abscess cavity, the needle of a hypodermic syringe was thrust in here in several directions until the barrel was found to be filling with a serous fluid, all of which was withdrawn, to the extent of about 2 drachms. On emerging from the anæsthetic, the patient was found to have fully regained his mental equilibrium, in which condition he remained five months later, the wound having quickly healed.

* Prof. Kocher (*La Sém. Med.*, April 12, 1899) has been obliged to prolong the drainage of a cerebral cyst for three years in order to ensure the disappearance of the epileptiform crises.

by the following list enumerated by Dr. Starr (*Brain Surgery*, p. 25):

"Any affection of the meninges, whether pachymeningitis or leptomeningitis, of traumatic or syphilitic or tubercular origin; or new growths upon or in the cortex of the brain; or cysts formed as the result of small circumscribed hæmorrhages, or of spots of softening from embolism or thrombosis of a cerebral artery; or circumscribed encephalitis or sclerotic patches, may act as centres of irritation in the cortex of the brain. The majority of these forms of disease, when exactly localised in a small area, appear to be traceable to traumatism, either to a blow, a fall on the head, or to a fracture with or without depression."

But it is not only the variety of the lesions of the brain which may, after an injury, produce Jacksonian epilepsy, that is worthy of careful note; it is their nature which, it appears to me, makes the majority of cases recurrent after any operation, however skilfully performed. At first sight hæmorrhages and cysts would appear capable of being dealt with by careful curetting, drainage, &c. (*vide supra*). But going with these coarser lesions there is almost always present some meningo-encephalitis, circumscribed or diffuse. Coen (*Ziegler's Beitr. z. Path. Anat. u. Physiol.*, 1888, Bd. ii. S. 107), van Gieson (*New York Med. Record*, April 24, 1893), Starr (*vide supra*)—the latter especially—have shown the frequency of the occurrence of adhesions between the pia and the cortex, of a chronic degeneration of the pyramidal cells, and of an increase in the neuroglia. The bearing of this on excision of the cortex will be alluded to later (p. 282).

Operation.*—To begin with, a painful cicatrix† may be freely excised. This may be done with some hope that nothing further in the way of operation will be required in cases where the scar is constantly painful, tender, or hot; where it corresponds to the course of some known nerve; and in any case where the original wound was lacerated, or contused, and slow in healing, and where there is any chance of a splinter of wood or metal being embedded in the scar.‡

If it be necessary, as it usually is, to remove a crown of bone, an appropriate semilunar flap (p. 358) must be reflected, with the aseptic and other precautions already given. Hæmorrhage is next arrested, and the flap retracted by Spencer Wells's forceps, the pericranium being

* During this, the surgeon must be on his guard for the sudden supervention of epileptic seizures or convulsive movements of one limb—*e.g.*, when he is pressing on a scar, or raising a crown of bone much thickened and adherent to the dura mater.

† Prof. Briggs (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 116), in a most excellent paper, in which large personal experience throws much light upon the subject, speaks of having had five such cases. After thorough removal of the scar, the wound was left to heal by granulation; in all the attacks were arrested. In one of Dr. Echeverria's cases (*loc. supra cit.*), convulsions, vertigo, &c., were cured by the removal of a small fibroma adherent to the frontal periosteum and supra-orbital nerve. Dr. Starr's opinion (*loc. supra cit.*, p. 68), on the other hand, is much less favourable: "From my experience I consider that true reflex epilepsy from scars in the scalp is a very rare occurrence."

‡ Dr. Johnson (*Clin. Soc. Trans.*, vol. vi. p. 35) records a case where trismus, facial neuralgia, and paralysis, with a recurrence of epilepsy (the patient, aged 44, had been free from fits for twelve years), were caused by a sharp, angular piece of flint embedded in a painful cicatrix of the cheek, the removal of which was followed by complete recovery.

carefully turned off the bone, and its condition noted as to thickening and other evidence of old inflammation. The bone being thoroughly exposed, the surgeon must be prepared for the following conditions—viz., the line of an old fracture, necrosis (indicated by a sinus with prominent granulations), hypertrophic sclerosis amounting, in some cases, to eburnation, and, on the under surface, depressed fragments of the internal table, spurs or nodules of bone. Any sequestrum will, of course, be removed. For dealing with the bone the surgeon will select out of those methods described at p. 359 the one with which he is most familiar. In trephining the surgeon will use the precautions given at p. 253, remembering that here he is especially likely to be dealing with a crown of bone of varying density at different points of its circumference.* It must be elevated with particular caution, as a spicule may have made its way through the dura mater and be pressing on the brain.†

If the first crown show nothing abnormal, a probe should be gently inserted between the bone and dura mater and carefully swept around, so as to give information of the condition of the inner surface of the surrounding bone. If the crown show changes which are, however, not localised to it, more bone must be taken away, preferably by the forceps of De Vilbiss (p. 363), till all that is thickened and capable of exerting pressure on the brain and its membranes is removed.

If no change can be found in the crown removed, or in the surrounding bone, what more should be done on this occasion? If there be reason to suspect the presence of an excess of cerebro-spinal fluid or of an abscess in the brain, because the symptoms of this condition (pp. 269, 301) are present, or because the dura mater bulges up without pulsation‡ into the trephine-hole, the treatment should be as directed at p. 306.

Directions as to dealing with any cysts, and how far it is wise to go in attacking thickened membranes, have been given at p. 279. These details of the operation would not be complete without some reference to the question of excising portions of the cortex where no lesion sufficient to account for the epilepsy has been found more superficially. This is not to be lightly undertaken. I have already (p. 275) pointed out that Prof. Nancrede, of Michigan, has with great candour recorded three cases in which he took this step; in all the fits recurred, though in one case not for two and a half years, while in another "somewhat over three years" had elapsed. And this candour is the greater as Prof. Nancrede allows that formerly he thought well of this procedure. Dr. Sachs and Dr. Gerster (*loc. supra cit.*) have given this

* Free and most embarrassing hæmorrhage may be met with in sawing through altered diploë traversed by large sinus-like venous channels, requiring firm pressure during and after the operation, plugging with a tiny sterilised wooden peg, or crushing the bone together with forceps at the bleeding point (pp. 265, 362).

† In one case Prof. Briggs (*loc. supra cit.*, p. 106), on elevating the bone, found that a spicule of bone had penetrated the superior longitudinal sinus. The hæmorrhage was arrested by pressure, and the patient made a good recovery from the operation.

‡ In a case of Dr. Oliver's (*Lancet*, 1887, vol. ii. p. 1183) the dura tensely through the wound. An incision was followed by a few containing shreds of fibrin. For a day " " erum amounti continued to escape.

method a full trial, having employed it in five cases. Their experience leads them to the conclusion that, in epilepsy of long standing, the excision of cortical tissue does no good, and such excision is hereafter to be restricted to epilepsies of short duration. And again: "Since such cortical lesions are often of a microscopical character, excision should be practised even if the tissue appears to be perfectly normal at the time of operation; but the greatest caution should be exercised to make sure that the proper area is removed."

Not only may this step cause severe hæmorrhage, shock, and open the door to infection, but it is impossible to see how it can do otherwise than lead to fusing of the scalp membranes and cortex in a scar which will become increasingly dense with time, and bring about "anchoring of the brain," with its grave disadvantages (p. 375) and sclerosis of the cortex, leading inevitably to a recurrence of the trouble. To put it briefly, it seems to me certain that when taking this step the surgeon is almost sure to replace one traumatic epilepsy by another, which, supervening somewhat later, is traumatic also, but in addition, unhappily, surgical as well.*

What is needed is to prevent the adhesion of brain, membranes, and scalp, and at present none of the methods used are reliable. Possibly transplanting a flap of scalp, bone, and membrane might succeed, but such a step is too severe to be undertaken at the close of an operation already severe and prolonged, and if deferred for some days its object would probably be defeated. The use of gold and other pliable metal plates between the dura and the skull will not prevent the formation of adhesions between the dura and brain. A case of Dr. Gerster's proves this. Having removed a cerebral cyst, this surgeon placed a gold plate between the dura and the skull. Two years and nine months after the first operation it was necessary to perform a second, and, while the gold plate was found lying exactly as it had been introduced, the best result attained was "that the surrounding tissue had undergone fewer changes than would have been the case if the ordinary scar had formed." Other materials have been suggested by the ingenuity of American surgeons. Beach has used gold-foil, Abbé rubber-tissue; but these substances have been proved to have the disadvantages of causing formation of adhesions and scar tissue, of disintegrating, and of causing suppuration. Dr. L. Freeman, of Denver (*Ann. Surg.*, Oct. 1898), having tried gold-foil in a case of trephining for cerebellar tumour, and found, three months later, that "considerable new connective tissue had formed," recommends the use of egg-membrane, as being inexpensive, readily obtainable, strong in spite of its thinness, and durable, and not, in the full sense of the word, a foreign body. The above claims are based upon two experiments on animals.†

Another objection to the removal of motor centres (except, of course, in cases where they are involved by a growth) is that this step may

* After mere incision of the dura or meninges, the cicatrix left will, no doubt, be linear and small, and the inner surface of the skull smooth and adhesions absent, but the condition present after removal of one or more centres will be very different.

† While the interval that Dr. Freeman allowed to elapse in one of his two cases is somewhat short, his method is so simple and easily employed that it deserves a wider trial.

merely replace one inconvenience by another. It is true that in most cases the loss of power has been temporary, but in some this has not been the case. Certainly not every patient would choose to lose his epilepsy at the cost of having a right arm or leg permanently paralysed.

Furthermore, it is easy to understand that in inexperienced hands permanent damage may be readily inflicted on the centres grouped about the motor area, bringing about a condition by which one form of distress will merely be exchanged for another.

If it be decided, owing to the gravity and frequency of the attacks,—especially where the condition amounts to the patient being practically in what is a *status epilepticus*—their limitation to one or two centres, the absence of any other extra-cerebral cause, and perhaps also the failure of a previous operation, to remove one of the motor centres, this should be accurately localised by electricity. To trust to measurements of the skull is not enough. Sufficient of the motor area having been exposed, the dura-arachnoid is opened and all hæmorrhage arrested. By means of two aseptic platinum electrodes, different parts of the motor area are examined, the results most carefully noted, and when that spot is reached which causes motion in that particular part of the body first affected in the fit, that particular spot, and that only, should be excised (Keen). Its limits having been determined, any large veins which enter the field of the operation are first tied with fine sterilised catgut passed under them by Sir V. Horsley's needle-director. The area of the centre is then marked out by a sharp knife held vertically to the surface and penetrating to the white matter. The centre is then excised by a sharp knife or scissors going to the same depth, about 3 mm., or a quarter of an inch. Hæmorrhage is best arrested by ligature of any bleeding points if possible, hot aseptic lotions, or compression with gauze wrung out of hot lotion, or sterilised adrenalin chloride. The cautery should never be resorted to if it can possibly be avoided. It introduces sepsis and suppuration, and may lead to a hernia cerebri and blood-poisoning (p. 339). It prevents the surgeon bringing together the flaps of dura mater over the excised centre. Drainage will usually be required on account of the oozing, and will be imperatively needed if the cautery has been employed.

After the removal of the centre, to make sure that this has been effectual, it will be well to again make use of electricity (Keen).

Most strict antiseptic precautions should be made use of before and during the operation; sufficient drainage should be provided, and, in bringing the wound together, the drainage-tube must not be pressed upon or closed. Great care must be taken to keep the wound sterile later on, infection leading to infective softening and hernia of the brain. Only if it has been needful to remove much bone should any of this be preserved and replaced, with the precautions given at p. 254.* In

* Prof. Kocher, of Bern (*La Sem. Méd.*, April 12, 1899, p. 121), is of opinion that not only should the bone-disc not be replaced, but that the dura mater itself should be widely excised. He holds that one of the chief causes of epilepsy consists in an exaggeration, local or general, of the intracranial pressure. He believes that, in a number of cases of excision of cerebral centres, except in those where the excision has been sufficiently complete to bring about a definite paralysis, the success should be attributed rather to

cases where during the operation there has been any escape of cerebro-spinal fluid, the dressings will soon need to be repacked or changed.

Causes of Failure after Trephining for Traumatic Epilepsy.—Amongst these are :

1. Not hitting off the right spot.—A bony spicule, undetected at the operation, has been found, at the necropsy, not far from the trephine-hole (p. 278). To meet this contingency, or to find a clot, it has been advised to sweep a probe or wire-loop (p. 279) carefully round the vicinity of the trephine-hole.

2. A general and diffuse thickening of the bone round the site of injury (*vide* p. 281, and footnote, p. 277).

3. Membranes too much thickened and too adherent to the cortex to admit of their being safely detached (p. 279).

4. Owing to the long continuance or to the amount of the irritation, the brain may be permanently affected (*vide supra*, p. 273). Thus in Dr. Chann's words already quoted (p. 246), there are cases of depressed fracture in which "the constant irritation has begotten a permanent impression upon the brain and nervous system which remains after the obliterating point of bone has been removed." The grosser and more localized the lesion, the more speedy will be the relief. As long as the fits are diminished in number and severity, the prognosis is still hopeful. The fits may be very slow in disappearing. The supervention of insanity is, of course, very grave.

5. While marked relief has been given in some cases of violent temper, delusions, and melancholia, whether associated or not with local epilepsy, the same rule holds with the former as with the latter, *i.e.*, if the interval between the injury and trephining has been a long one, the cure is very likely to be imperfect.

6. Neglect of after-treatment, both medical and surgical, but chiefly the former. Prof. Namerode's words (*Intern. Enc. Surg.*, vol. v. p. 102) are worthy of remembrance : "The operation, indeed, removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the

the opening of the dura mater, which establishes a sort of safety-valve susceptible of regulating the intracranial pressure. In other cases he has seen, after incision of the dura mater, not only epileptiform seizures, but spasms and paresis, disappear. In cases where traumatic epilepsy has been definitely cured he has been able to prove that the site of trephining was filled in by a supple membrane, or showed a loss of substance capable of acting as a safety valve ; while in those cases in which a recurrence of the fits took place the membrane was resisting and immobile. Koehler would therefore only put back the disc where a very definite lesion, such as an exostosis or growth, has been removed ; in all others the skull should be left open. According to von Bergmann (*loc. supra cit.*, p. 411) Prof. Koehler having found that large cystic scars and much cerebro-spinal fluid in one or both lateral ventricles are frequently found in cases of traumatic epilepsy, "recommends lumbar puncture and puncture of the ventricles, also drainage of the ventricles, and the establishment of large openings in the skull with movable coverings. For this purpose he reduces the size of the bone-flap, after it has been turned down, to such a degree that, after being replaced, there remains a permanent defect in the skull about one finger's breadth wide, covered only by the soft parts. He ascribes to this operation the function of a safety-valve, and claims to have cured more cases of epilepsy by this procedure than by any."

nervous system, can only disappear with time ; and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly, if at all, benefited, whereas judicious after-treatment will sometimes relieve an apparent operative failure." I would also refer my readers to the words of this authority quoted at p. 276. The words "judicious after-treatment" should especially refer to alcohol, exposure to the sun, overheated small rooms, &c.

7. Trephining for fits not belonging to traumatic epilepsy in character.—There is no doubt that the glamour of a new operation and "the chance of finding something" have led to this operation being performed in unsuitable cases, which have not been published. It cannot be too strongly laid down that no operation is justifiable in other epilepsies save the Jacksonian, of which so many are traumatic in origin. That is to say that in ordinary idiopathic epilepsy the conditions justifying operation must be of the very rarest. They would be something of this kind: Epilepsy with intense local headache; Epilepsy in which, after the general convulsions, paralysis or paresis of any group of muscles follows. Those who trephine in idiopathic epilepsy because it is impossible always to exclude traumatism in idiopathic cases, or because there is a bare possibility that a hæmorrhage, the origin of irritation, may be met with on the surface of the brain, are likely to meet with disappointment. The following case shows that an exact diagnosis as to the nature of the fits is not always easy. It was one in which Mr. Hulke trephined for "anomalous" convulsive attacks supervening several months after a head injury (*Med. Times and Gaz.*, 1881, vol. ii. p. 85).

The operation, while it did no harm, was useless. Bromide and iodide of potassium having been tried in vain, a full trial of valerianate of zinc was made, the fits subsiding under this treatment. This fact, the way in which the fits came on, the slight degree of unconsciousness, its gradual onset, and the fact that occasionally the first convulsion had the aspect of purposive movements, supported the view that the fits were not epileptic but hysterical, induced by the shock of an accident in a person of unstable nervous system. On the other hand, the traumatic origin, the headache, the darting pain on touching the part injured, were all suggestive of some chronic irritative process, and justified the operation of trephining.*

8. An infected condition of the wound, almost invariably the fault of the surgeon, and bringing about (a) meningitis, (b) hernia cerebri, (c) cerebral abscess.

9. Shock.

Finally, in cases of honest doubt, and in those where a well-considered operation has failed, the interference of the surgeon will be justified by the fact that traumatic epilepsy tends to grow worse, and is little affected by medical treatment. In the words of Echeverria (*loc. supra cit.*, p. 277), once declared, traumatic epilepsy, due to injury to the head, leads to early insanity or to feebleness of intellect.

* It is noteworthy that the bone removed and the dura mater being normal in this case, an aspirator-needle was pushed through the latter to the depth of an inch, and then withdrawn, as nothing escaped through it. For a few minutes, owing to the high intracranial pressure, cerebro-spinal fluid spurted in a slender stream for the distance of nearly a foot, and continued to leak away for several hours.

TREPHINING FOR MASTOID ABSCESS AND CEREBRAL ABSCESS, THE RESULTS OF OTITIS MEDIA

(Figs. 108 to 121).

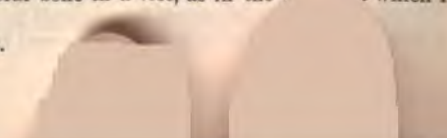
POINTS OF PRACTICAL IMPORTANCE TO THE SURGEON IN THE ANATOMY OF THE PARTS CONCERNED.*

I. Tympanum.—(a) Roof always thin, not more than a line and a half in thickness, often thinner.† Through this, inflammation in otitis media readily reaches the brain, causing meningitis, sub-dural or cerebral abscess. (b) Parts of the brain and cerebellum which are in contact with the middle ear. These are the middle and back part of the temporo-sphenoidal lobe, and the outer and front part of the lateral lobe of the cerebellum. With regard to this latter site of abscess, Mr. Toynbee held that the greater frequency in adults of thrombosis of the lateral sinus and, with this, of cerebellar abscess was due to the development of the mastoid cells backwards. (c) The mucous membrane and the endosteum lining the tympanum are in most intimate contact; hence, in otitis media, caries and necrosis readily occur, especially if the blood-supply to the tympanum from the dura mater is cut off. (d) The skin of the external auditory meatus is continuous with the membrana tympani, and thus otitis media may be set up from without, as well as by mischief reaching the tympanum through (e) the Eustachian tube, which enters in front, and makes the mucous membrane of the throat continuous with that of the tympanum. (f) The outlets of the mastoid cells and of the tympanum are inadequate for drainage in otorrhœa, as many of the mastoid cells lie below the level of their opening into the tympanum, and the floor of the tympanum is, in part, below the orifice of the Eustachian tube. Decomposition, once started, is thus favoured.

II. Mastoid Cells.—(a) Their development varies with age. In adults, if well marked, they may measure $1\frac{1}{2}$ inch horizontally, 2 inches vertically, and reach quite up to, and even around, the lateral sinus. (b) Two groups of cells are present, and their relations are of the utmost importance—A. The upper, or antrum, present both in early and later life, horizontal in direction and closely adjacent to and contiguous with the tympanum. B. The lower, or vertical. These cells are not developed in early life, and vary much in their contents. In only about 20 per cent. do they contain air. The mastoid antrum is of far greater importance. This is a small chamber lying behind the tympanum, into the upper and back part of which (the tympanic attic) it opens. Its size varies, especially with age. Present at birth, it reaches its largest size, that of a pea, about the third or fourth year. After this it usually diminishes somewhat owing to the encroachments of the developing bone around it. Its roof, the tegmen antri, is merely the backward continuation of the tegmen tympani. The level of this

* These should be studied together with a skull and one or two sections of a temporal bone. And, far better, the surgeon who may be called to perform operations here should go over the field, having fixed the temporal bone in a vice, as in the specimen which I prepared for Fig. 108.

† The bony roof is occasionally absent.



is indicated by the horizontal root of the zygoma. "The level of the floor of the adult skull at the tegmen antri is, on an average, less than one-fourth of an inch above the roof of the external osseous meatus; in children and adolescents, from one-sixteenth to one-eighth of an inch" (Macewen). The *outer wall* of the antrum is formed by a plate descending from the squamous bone. This is very thin in early life, but as it develops by deposit from the periosteum, the depth of the antrum from the surface increases. Macewen gives the average of this depth as varying from one-eighth to three-quarters of an inch. At the junction of the two parts of the outer wall of the mastoid cells is the squamo-mastoid suture, often present at puberty. Through the *floor*, the antrum communicates with the lower or vertical cells of the mastoid. This floor is on a lower level than the opening into the tympanum, and thus drainage of an infected antrum is difficult, fluid finding its way more readily into the lower cells. *Behind* the mastoid antrum is the bend of the sigmoid part of the lateral sinus, with its short descending portion.* The following are Sir W. Macewen's directions for exploring this important vessel: "An opening in the bone, with its posterior margin touching a line drawn from the parieto-squamo-mastoid junction to the tip of the mastoid, and drawn within the parallels of the external auditory meatus, will expose the part of the sinus most often affected with thrombosis. The above junction of the asterion is placed about three-quarters of an inch in front of, and half an inch above, the upper part of the posterior border of the mastoid." The sinus lies more superficially than the antrum, being usually one-fourth of an inch, occasionally half an inch from the surface.

The exact position of the antrum, a little above and behind the external auditory meatus, is represented by Macewen's "supra-meatal triangle." This is a triangle bounded by the posterior roof of the zygoma above, the upper and posterior segment of the bony external meatus below, and an imaginary line joining the above boundaries. "Roughly speaking, if the orifice of the external meatus be bisected horizontally, the upper half would be on a level with the mastoid antrum. If this segment be again bisected vertically, its posterior half would again correspond to the junction of the antrum and middle ear, and immediately behind this lies the supra-meatal fossa" (Macewen). When opening the antrum through this triangle the operator should work forwards and inwards, so as to avoid the sigmoid sinus, while to keep clear of the facial nerve (Fig. 113) he should hug the root of the zygoma and the upper part of the bony meatus as closely as possible, and not continue his perforation more forwards than is absolutely needful. The level of the base of the brain

* Körner, of Frankfort, has shown (*Arch. of Otol.*, vol. xviii., 1889, p. 311) that fatal intracranial diseases (meningitis, sinus-phlebitis, and abscess) more frequently occur with disease of the right petrous than the left. This is due to the fact that the right lateral sinus, at its sigmoid flexure, comes more forward into the mastoid and base of the petrous than does the left, and therefore, with its dura mater, lies nearer to the primary disease. This is explained by the passage of blood down into the heart being easier and more direct on the right side, and this sinus being, accordingly, more voluminous.

will be a few lines above the posterior root of the zygoma (Fig. 108), and about one-quarter of an inch above the roof of the bony meatus.

FIG. 108.



The outer wall of the mastoid bone, the antrum, attic, and tympanum, together with the posterior wall of the osseous meatus, have been removed here in order to show the field of operation in a case of chronic extensive disease. It will be noticed that the mastoid cells, both horizontal and vertical, are widely developed. 1, Posterior root of the zygoma, forming the upper boundary of Macewen's triangle. 2, Antrum and, in front of it, the attic. 3, Vertical cells of the mastoid. Where these are well developed and become infected, Bezold's mastoiditis (p. 295) will occur. 4, Ridge on the inner wall of the tympanum indicating the Fallopian aqueduct. 5, Fenestræ in the inner wall of the tympanum, indicated in shadow. 6, A natural deficiency in the tegmen enlarged with a small osteotribe to remind my readers how thin is the roof of the antrum and tympanum. 7, Cells present in this case, even in the zygoma at its junction with the middle root. This will show how difficult it is in some cases to bring about complete asepsis.

In the first few years of life certain points of difference exist in the anatomy of the antrum, which are of practical importance. Speaking generally, the thinness of the outer wall and the presence of the squamous foramen favour the escape of infected material to the outside of

the skull, while the small degree of development of the mastoid cells also helps to render less frequent intracranial complications at this age, especially thrombosis of the sigmoid sinus. Mr. H. Stiles (*Brit. Med. Journ.*, vol. ii. 1898, p. 1142) points out two more anatomical details which should be remembered. During early life the undeveloped condition of the mastoid process leaves the stylo-mastoid foramen exposed upon the lateral, not the under, surface of the base of the skull. In making the first incision, therefore, by which the soft parts are reflected from the bone, the surgeon should take care, below a point on a level with the middle of the meatus, to make his incision a superficial one only, to avoid injuring the facial nerve. Secondly, the posterior root of the zygoma, which in the adult forms a surface-guide to the level of the roof of the antrum, does not now exist.

The following are all different ways by which infection may reach the brain from the ear: (1) Through the roof of the antrum, especially if the bone be naturally deficient here, into the middle fossa; (2) by the lateral sinus into the posterior fossa; (3) by the labyrinth and internal meatus into the posterior fossa; (4) by the different sutures with their contained processes of dura mater;* (5) the veins which pass from the tympanum and mastoid cells. These fall into three chief groups: (a) those opening into the lateral sinus; (β) those passing through the mastoid foramen into the occipital vein and soft parts outside the skull; (γ) those running through the petro-squamosal suture to the dura mater. All these veins carry sheaths of connective tissue, and thus inflammatory products may reach (a) the lateral sinus, causing septic phlebitis; (b) the soft parts outside, causing periostitis, cellulitis, &c.; (c) the dura mater and brain, causing meningitis and abscess.

FOUR RESULTS OF OTITIS MEDIA WHICH MAY COME UNDER THE NOTICE OF THE SURGEON.—(i.) Acute inflammation of mastoid cells: mastoid abscess; (ii.) abscess in the brain or cerebellum; (iii.) infective thrombosis of the sinuses and pyæmia; (iv.) meningitis.† N.B.—The above four often co-exist, and thus the symptoms may be much blended together and confusing.

Indications for Interference in Mastoid Disease and Otitis Media.

A. In Acute Cases.—As is stated below (p. 291), a clear distinction must be made between acute and chronic cases. In a very few acute cases, where the surgeon is without skilled help, where the mischief is localised to the mastoid, where the periosteum and soft parts are much involved,‡ where the patient is young and the parts are yielding, where no evidence of grave septicæmia is present, the surgeon will be justified

* The sutures may be of fatal significance. Thus in cases where there is infective mischief outside the bone, the infection having made its way there by an opening in the mastoid, or, where this is sclerosed, by dissecting its way along the external auditory meatus, if it reach a suture and its contained process of dura mater, infection of the inner surface and meningitis may easily follow. Schwartze has recorded (*Arch. f. Ohrenheilkunde*, Bd. xxii. S. 295) a case of temporo-sphenoidal abscess in a child, in which infection reached the brain through the petro-squamosal suture.

† According to Poulsen (*Arch. of Otol.*, July 1892, p. 346) the relative frequency of the latter three complications is about the same. Thus, out of 36 cases of complications of otitis media there were 13 cases of abscess, 12 of sinus thrombosis, and 11 of meningitis.

‡ I would remind my younger readers that redness, swelling, tenderness, may be very little marked in suppuration in the mastoid, especially if the bone be sclerosed.

in making a free incision down to the bone, and enlarging and curetting out any soft patch that he finds in the antrum. But, as a rule, in acute cases the antrum should be freely opened and disinfected (*vide infra*).

B. In Chronic Cases.—Here the decision is sometimes extremely difficult, and the operation, if any be needed, must be an extensive and difficult one.

I consider operative interference called for, in practised hands, in the following cases:—

1. Where, in a chronic case,* urgent symptoms pointing to septicæmia or cerebral mischief—*e.g.*, headache, earache, pyrexia, vomiting, dizziness, a rigor, optic neuritis—are present.

2. Where, in a chronic case, there is a history of such grave symptoms as those above given.

3. In obstinate disease of the mastoid. Under this heading should be included—(a) Chronic disease of the mastoid with recurrent attacks of swelling; (b) Fistula over the mastoid; (c) Persistent neuralgia over the mastoid (Schwartz). Whenever the question of a diseased mastoid arises, the apex must not be forgotten (Fig. 108, p. 288).

4. In cases of long-standing discharge, baffling treatment, but without any severe symptoms. It is these cases which present the most difficulty, if the long duration of the case and the recurrent and rebellious nature of the discharge are the only factors in the case. Here the surgeon will be guided in his decision by the rank of life of the patient, *i.e.*, how far he is intelligent, aware of the grave peril, which may become urgent at any time, and therefore willing to persevere with needful treatment and to remain under regular observation. The nature of the discharge, *i.e.*, the degree of infection and its amount when it recurs,† the presence of any persistent bare bone, must be taken into consideration. The age of the patient, whether one entering on the best years of his life, and, again, whether he is one whose denial of any past evidence of anything approaching to the grave symptoms I have mentioned is to be disregarded, or one who would at once pay attention to any threatening of them, must also be considered.

5. Of course, when cerebral symptoms are present, when these are acute, each operator must decide for himself whether he take the antrum first or no. If the cerebral mischief is not extremely urgent, and if skilled assistance is at hand, the antrum should, if possible, be taken first, so that one operation may suffice. If the operation on the brain is a difficult one, that on the antrum may have to be deferred. When the cerebral symptoms are only slight, *e.g.*, a slight degree of optic neuritis, headache, dulness, &c., it will be justifiable to perform the operation on the antrum first, and to wait and watch carefully. For a slight degree of meningitis may subside after free drainage of the antrum and adjacent parts.

* Mr. Barker drew attention, some years ago, to the greater gravity of old-standing cases. Thus, otorrhœa does not cause cerebral abscess till it has lasted months or years. In only two of the cases which Dr. N. Pitt collected in his *Gulstonian Lectures*, 1st the duration of the otorrhœa under a year.

† A discharge may have ceased owing to the formation of a plug of inspissated or of granulations. It may be increased by some blow, exposure to cold, instruments, or to some independent pyrexia, of which influenza is certainly o

Antrectomy.—Operation based on those of Schwartz and Stäcke.

The name of Schwartz, of Halle, is associated with the first attempt to put operations on the antrum on a satisfactory footing, he having published, in 1873, a series of cases in the *Arch. f. Ohrenheilkunde*, Bd. vii. u. ix. Replacing such very limited operations as that of Wilde's incision and drilling the bone, Schwartz opened up the mastoid cells and antrum, establishing drainage between these and the tympanum, and keeping the communication open by plugging or a leaden nail. This pioneer operation, though excellent and based on correct principles, admitted of improvement. It was used extensively for many years, with the result that it was found admirably adapted for acute, but insufficient for some chronic cases where the mischief was extensive. Stäcke in 1892 published (*Arch. f. Ohrenheilkunde*, Bd. xxxi.) his operation, which modified that of Schwartz in the following important details—viz., the detachment of the auricle, the removal not only of the outer wall of the antrum but the upper and outer part of the bony meatus, the taking away of the ossicles and membrana tympani, and the replacing of the flaps of the auricle.

I have tried to describe here, with sufficient detail, operative steps which will meet different cases of varying severity. When in doubt as to which operation should be performed, the surgeon will be guided mainly by the amount of disease in the tympanum, the duration of the disease, the condition of the patient, the failure of any previous operation, and the operator's own experience. In recent cases, in those where the disease is limited to the mastoid, often in children, and in those instances where another operation is to be performed at the same time—e.g., for cerebral abscess or sinus-thrombosis—the simpler operation of Schwartz should be employed. If any surgeon decide on performing the less severe, but also less complete, operation, in cases where chronic disease of the tympanum exists, he must remember the consequences of his step. He will relieve his patient especially from the gravest risks, but he will not remove these entirely. He must be prepared for after-treatment often very tedious, with persistent discharge and smell from the meatus, and the troublesome formation of granulations along his operation-track, which obstinately tends to close. This must be kept open (*vide infra*) as long as possible, and the patient must be kept under observation for assiduous, persevering treatment as long as any discharge persists.

The parts having been shaved, cleansed as thoroughly as possible, preferably some hours before, and an anæsthetic (perhaps the best, on the whole, is A.C.E.) cautiously given, a free incision is made with a strong-backed scalpel, starting "above, a little in front of the top of the pinna in the line of the hair. It is carried backwards, and then backwards and downwards, still following the line of the hair till that line passes on to the neck. It is then continued downwards and forwards to the posterior part of the apex of the mastoid. This is a free incision of Chaput" (Ballance). If the parts are to be free, they should be very free.* With an elevator or curved

tion given about the exit of the facial nerve (p. 289) will be of the lateral sinus is so variable—sometimes quite close to

blunt-pointed scissors, the auricle is well separated from the bone and pushed well forwards and somewhat downwards, together with the skin lining the meatus, especially at its upper part. Only when the parts are succulent with inflammation will this step be easy. Spencer Wells's forceps quickly taking up the flaps (p. 252) and bleeding points* will act as retractors, but the auricle will require to be well held forwards, and a very efficient means is a strip of sterilised gauze passed through the meatus and out of the wound, its two ends being knotted and used as a retractor. By this means the bony meatus—especially the part needed, the upper and back part and the supra-meatal triangle of Macewen (p. 287), which is the guide to the antrum—can be defined. Any discoloured patches, opening in the bone, emissary veins, or suture-lines are now looked for. If any opening be present it is enlarged. In most cases no such guide is present, and the antrum must be opened through the supra-meatal triangle. This is effected in different ways according to the density of the bone. This may be soft and spongy, or sclerosed, especially in long-standing cases; between the two, varying conditions are met with.† If the bone be soft enough, the use of the gouge (Fig. 109) is best, and will soon effect an entrance through the compact outer layer. But the gouge should be worked with the hand alone as much as possible, and the mallet used with the utmost care and only in removing the outer layer of bone.

Sir. W. Macewen (*Pyogenic Diseases of the Brain and Spinal Cord*, p. 303) gives the following objections to the use of the chisel or gouge and mallet: 1. "Because, in operating upon a restricted area, surrounded by and full of apertures, some containing delicate structures, the wounding of which may occasion serious and even fatal results, the antrum being situated at a variable depth from the surface, the intervening osseous tissue being of various consistency, it is a source of danger to use a chisel driven by a mallet, which may be suddenly impelled into the interior of one of these spaces, or into the cerebellum, brain, or sigmoid. Such accidents have occurred. During attempts to open the mastoid antrum, the sigmoid sinus has frequently been accidentally opened by the chisel, several of the cases surviving,

the auricle, sometimes only near it, and sometimes well out of danger—it is best to keep close to the auricle. If the surgeon is not only going to open the antrum, but also to explore the lateral sinus, cerebrum, and cerebellum, he will make use of the incision given at p. 309, or that recommended by Mr. Dean (p. 308, Fig. 120).

* Thrombosis of any vein superficially met with will foretell a similar condition in the lateral sinus.

† In an examination of 100 fresh and 150 macerated specimens, Zuckerkandl found in 20 per cent. an absolute absence of pneumatic cells: 38 per cent. were pneumatic, without any diploë. In some cases the upper half only of the mastoid was pneumatic, the lower half containing diploë. Anyone who has seen much of mastoid surgery will agree that no two processes are exactly alike. Sclerosis of bone when present here may be a normal condition; but, whether normal or pathological, it is of importance (1) in adding decidedly to the difficulties of the operation, both by rendering it more difficult to decide when the antrum—which is smaller in proportion to the amount of sclerosis present—is reached, and by making accidents—*e.g.*, injury to the facial nerve—more likely; and (2) in preventing the approach of infective mischief to the surface, and thereby rendering intracranial complications more probable.

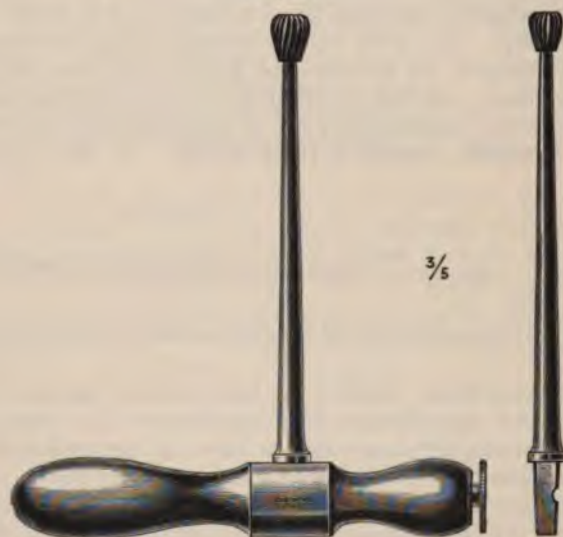
though a number have died. On one occasion a young surgeon, in endeavouring to open the antrum with a chisel, found, on giving it an impact with the hammer, that the instrument suddenly entered a large cavity, from which pus issued. At the post-mortem examination it was seen that the chisel had penetrated the sigmoid groove, pushed aside the sinus, which was fortunately thrombosed, and entered the cerebellum, from which, on withdrawal of the instrument, pus flowed. 2. Secondly, the repeated blows with the hammer impart considerable vibration to the mastoid and adjoining structures, and when the tegmen tympani or the sigmoid groove is eroded and thinned, the concussion may cause these thinned and friable structures to give way, or cause

FIG. 109.



Macewen's gouge. This is of the right length to rest safely in the palm of the hand while the point is protected with the forefinger.

FIG. 110.



Osteotribes or burrs, for use with an ordinary trephine-handle. (Made for me by Down Bros.)

a rupture of the granulations covering them, and thus permit inoculation of the fresh wounds in the membranes, or in the brain itself. Pus within the brain or cerebellum, receiving through the skull a succession of violent vibrations or shocks, could easily be scattered, or a large abscess near the ventricles or meninges might, by the violent impacts conveyed to it, burst into the ventricles or meninges, thus producing serious if not fatal results." Sir W. Macewen prefers the use of drills and burrs worked by an electro-motor. But, as such means are rarely to hand, the surgeon must remember the above warning and use a mallet with much caution, and burrs (Fig. 110) as much as possible.

Mr. Ballance, another authority on the subject, also prefers burrs worked by an electro-motor* (*Med.-Chir. Trans.*, vol. lxxxiii. p. 900). His burrs are of the cross-cut, not the ordinary shape, and 9 mm. and

* Mr. Ballance's burrs are made by Ash & Co., his electro-motors and accumulators by Curtis, of Dublin. The electro-motor and box weigh 25 lbs., the accumulators the same.

7 mm. in diameter. He points out that the burr must be kept moist by a stream of antiseptic fluid, and that it must not be pressed against the bone, but kept in constant movement over the area to be removed. The burrs can be fitted with protectors. Where no electro-motor and burrs are available, Mr. Ballance recommends the gouge. For removal of the bone superficial to the antrum he uses sizes 15, 11, and 8 mm. in diameter. The cutting edges should not be curved. He prefers two smaller and longer gouges for removal of the outer wall of the attic, and, while they are in use, Stäcke's guide (Fig. 112) serves to shield the tuberosity which projects from the inner wall into the neck of the antrum (Fig. 108). It contains the Fallopian aqueduct and the horizontal semicircular canal.

Whatever instrument is employed, it should be directed forwards and slightly upwards, so as to avoid the sigmoid sinus and facial nerve (p. 287). As soon as the compact layer is removed, the gouge and osteotribes, or rose-headed burrs (Fig. 110), will quickly increase the opening. As this is effected, the surrounding surface should also be cut away, cautiously, as it is unsatisfactory and dangerous to work in a cramped, conical, pit-like cavity. As the opening is deepened the

FIG. 111.



Macewen's combined small curette and seeker. The latter will serve as an ossicle-hook.

surgeon tests whether he has reached the antrum, partly by looking out for any minute dark apertures—*i.e.*, diploic spaces—partly by examining the fragments he removes for evidence of cancellous tissue, and finally by seeing if he can pass a fine probe along the iter into the tympanum. As the operator goes along, all blood, granulation tissue,* pus, &c., are removed by sharp spoons, dossilis of dry sterilised gauze, and, if by irrigation, with the precautions given below (p. 298). In acute cases the operator should also be on the look-out for any pus welling up, and note whence it comes—whether from behind, the neighbourhood of the sigmoid sinus, from in front, the tympanum, or from above, pointing to the middle fossa. Hæmorrhage, usually free and often troublesome, is arrested by pressure with dry sterilised gauze. It is well to have plenty of small rolls of this prepared beforehand. Occasionally it is profuse, although the instrument used has not been allowed to trench upon the sigmoid sinus; in such cases it may come from a branch of the occipital or stylo-mastoid artery, or from a mastoid vein coming through unusually far forwards. In these cases pressure must be kept up for several minutes, or a small plug of sterilised wood inserted.

* Sir W. Macewen (*loc. supra cit.*, p. 301) gives the following warning as to the importance of buds of granulation tissue: "It frequently happens that granulations springing from the dura lining the cerebellar fossa, and covering the sigmoid sinus, protrude through the sigmoid groove, and project into one of the mastoid cells. When these granulations project in this way from the cerebellar dura, there is a localised pachymeningitis, and probably a more or less thrombosed sigmoid sinus."

The depth at which the antrum may be situated from the surface varies from one-eighth to three-quarters of an inch, or even more. Occasionally it may be absolutely obliterated by hypertrophic sclerosis* (Macewen). The same authority states that he has met with it placed higher up than usual, "somewhat above the level of the outer limit of the floor of the middle fossa, the downward projection of which had to be rounded in order to reach the antrum." He adds that "it is possible, in some of the reported cases in which the antrum could not be found during operation, that it was situated in this manner." Mr. Ballance (*loc. supra cit.*) considers "that it need never happen that the antrum be not reached, as some operators have described, for the attic can always be found, and a bent probe passed backwards from the attic into the antrum will be a sure guide to the exposure of this cavity." Where no antrum can be found, or where one is present but contains no pus, the surgeon should always remember the vertical group of cells (p. 288, Fig. 108) and the apex of the mastoid, in adults. Occasionally cells may be present here and absent above. It is in such cases that Bezold's mastoiditis, with perforation on the inner side of the apex, and suppuration in the digastric fossa and under the sterno-mastoid, may occur.

Having thoroughly dealt with the mastoid cells, the surgeon must decide whether this is sufficient. If it be a recent and acute case, it will be enough to irrigate the cavity with boiled water, carbolic acid lotion (1 in 20), or iodoform emulsion, and then to plug it with sterilised gauze, the wound in the soft parts being only partly drawn together with salmon-gut sutures. But if the case be a chronic one, the tympanic cavity infected and carious, the surgeon must either do more on the lines of a Stäcke's operation given below, or leave his patient to such an operation at a later date, or tedious and prolonged after-treatment. If for any reason, perhaps the condition of his patient, he hold his hand in a chronic case, he should carefully curette the tympanum from the external bony meatus and try and pass a small drainage-tube between the bony meatus and the opening into the antrum. If this step be found impossible,† a stream of boiled water or boracic acid should be syringed between them in both directions, and an emulsion of iodoform and glycerine allowed to trickle into the two openings, or iodoform sterilised in a solution of formalin (1 in 500), or in one of carbolic acid (1 in 20), inserted with a fine curette.

I shall now suppose that the case is one of advanced disease spread over a considerable area, a case of long standing, and calling for further investigation on the lines of Stäcke's operation (p. 291). The tympanum

* "When great depth is associated with eburnated bone from sclerosis, the task is a formidable one. If in such cases the sigmoid sinus is situated close to the posterior wall of the canal, the difficulty of reaching the antrum is almost insuperable" (Barr). Small instruments are absolutely essential here, and it is in these cases that small burrs will be found of great assistance.

† If the surgeon fail in getting a drainage-tube through, or even in syringing from one cavity to the other, he need not be unduly disappointed. He will have improved the condition of his patient very considerably—a point demonstrated in the large series of cases published by the late Dr. Ferrer, of San Francisco (*Arch. of Otolology*, vols. xviii. and xxii.)—but a cure, depending on the amount of infection left in the tympanum, can only be brought about by time, and assiduous perseverance with the after-treatment.

next requiring the attention of the surgeon, the entrance into this cavity is identified by a Stäcke's guide (Fig. 112) passed along the iter or attic, then all the bone outside this and the outer and upper wall of the meatus are very carefully cut away with a small chisel or gouge. In effecting this the operator should keep his instrument carefully upwards as well as forwards, and be very careful that it is the outer and not the inner wall of the antro-tympanic passage with which he is dealing, and that he does not descend below the upper part of the posterior wall of the meatus, for fear of injury to the facial nerve.* The anæsthetist should also now carefully watch for any twitchings of the face.

The following warning of Sir W. Macewen (*loc. supra cit.*, p. 300) as to the need of care in dealing with granulations at this stage bears on this point: "Another danger to which the facial nerve is exposed arises when a granulation-mass, protruding through an extensive erosion in the canal, encloses the facial nerve; the surgeon, in clearing the granulation tissue from the floor of the antrum, is apt to injure

FIG. 112.



Stäcke's guide. (Down Bros.' Cat.)

the nerve. Before removing granulation matter from the floor of the antral passage the granulation buds should be touched with a probe, when, if they enclose the nerve, facial twitchings will result."

At this stage a bright light and efficient drying of the parts with dossils of sterilised dry gauze are most helpful. (Ballance.)

Cutting away of the outer and upper wall of the meatus, the outer wall of the antrum and attic, will enable the surgeon to inspect the state of the membranes and ossicles. If the latter are bare of mucous membrane, covered with granulation-tissue, carious, or loose, they should be removed, and in all long-standing cases the remains of the membrane and any polypi should be cleared away also. The tympanum, the attic and the antrum, and the external meatus having been thrown into one large cavity, the surgeon examines with a probe for the existence of any outlying cells and pockets with pus; if the vertical group of mastoid cells is developed, and if there be any doubt about

* Paralysis of the face coming on some hours after the operation is not very uncommon, and is probably due to oedema around the nerve in its canal. It will disappear, though sometimes tediously. This paralysis is especially likely to occur where any natural gap or a pathological erosion exists in the bony canal while the nerve is in relation to the tympanum. If either of the above be present, the neurilemma of the nerve and the mucous membrane of the tympanum will be in close contact with each other. Paralysis noticed, as soon as the effect of the anæsthetic passes off, is due to the operation, and is likely to be permanent.

their being aseptic, they should be opened up to the apex of the bone, and all intervening and irregular septa removed with osteotribes so that the opening is not only large but smooth. Another point which should always be looked into is the roof of the antrum. If a black patch is to be seen above, or if a probe finds a perforation here, this should be carefully enlarged, and the roof, indicated by the level of the posterior root of the zygoma (Fig. 108), carefully gouged burred, and cut away, until the middle fossa is exposed sufficiently to examine the dura mater above the roof of the antrum. This may show a meningitis,

FIG. 113.



Drawn from a specimen prepared by Hamilton Ballance. The complete mastoid operation has been performed.

- 1, Inner wall of antrum.
- 2, Inner wall of attic.
- 3, Inner wall of tympanum proprium.
- 4, Ridge of the aqueduct. Under cover of this is the "recessus tympanicus sub-aquæductū Fallopii." The dotted line indicates the backward and upward extension of the recess. (Ballance.)

local or, too often, part of one diffused, an extra-dural abscess (p. 315), or a sloughy perforation in it may lead to an abscess in the temporo-sphenoidal lobe (pp. 301, 305). The next step is to examine the sigmoid sinus* by removing the bone carefully in a backward direction (p. 313). A dark patch posteriorly may indicate mischief here. Before the surgeon considers the operation completed he should examine again with fine probes for any outlying cells or pockets. The number, size, and extent of the mastoid cells vary in nearly every case, and their

* If a healthy, unthrombosed sigmoid sinus has been accidentally opened, the treatment should be that given at p. 248. Unless the neighbouring parts are aseptic this complication is a serious one, owing to the risk of infective phlebitis.

disinfection must be carried out thoroughly and efficiently; when the surgeon is in doubt about this he will use emulsion of iodoform in glycerine (10 per cent.), solution of zinc chloride (gr. xx. to 3j.), or pure carbolic acid. Watery solutions, save a saturated one of boracic acid, should not be run in too freely in case the Eustachian tube is patent; and, for the same reason, solutions of hyd. perch. should not be employed. Incomplete disinfection of the parts, the persistence of a sinus soon becoming fœtid, means an incomplete operation. Again, if the wound heal and tenderness or headache return, a bead of infective pus is probably pent up in some unexplored nook or cell. Having satisfied himself that he has thoroughly exposed and dealt with the whole of the diseased area, it remains to take steps which will ensure

FIG. 114.



The posterior edge of the inner extremity of the cartilaginous meatus is shown dislocated outwards, and a long narrow knife has been passed along the length of the meatus through the conchal opening. The white space shown in this and in Figs. 116 and 117 represents the bony area which has been operated on. (Ballance.)

the healing of the large wound from the bottom, completely. To diminish the large size of the wound, and thus to lessen the amount of plugging required, and to prevent any permanent opening being left which would require a subsequent plastic operation the following steps have been suggested: A director is passed along the meatus and out at the mastoid wound, the soft parts are slit along this for the whole length of the canal and well out on to the concha, while at the outer extremity of the horizontal cut one is made at right angles to it, so as to form rectangular flaps and to open out the folded cartilage. The edges of the mastoid wound having been brought partly together, without tension, the edge of the upper flap is sutured to this wound at its upper, and the lower flap at its lower, part.* This not only covers in the large gap, but it leaves a permanent external meatus of large

* Numerous modifications of this plan, and other steps for closing persistent fistulæ are mentioned by Dr. P. McBride (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1128).

size (it should be large enough to admit the little finger), which enables the surgeon to scrutinise the wound as it heals, and to prevent any accumulation of pus, granulation material, &c., re-collecting, while it renders a recurrence of the disease very improbable (Bronner, *Brit. Med. Journ.*, vol. ii. 1896, p. 1114). The hæmorrhage which occurs during the making of the above flaps is usually at once controlled by the sutures, which should be passed deeply.

The flaps must be kept *in situ* by means of strips of sterilised gauze. If the surgeon have two regions to drain, such as the antrum and the tympanum, one of which is aseptic and the other not, separate deep dressings must be employed. Where there is much oozing, firm pressure, by means of a knotted bandage, will be required. Free hæmorrhage, if dark, a few days after the operation, points to erosion of some sinus, and will generally yield to effective aseptic pressure. Iodoform should not be too long or freely employed, as it tends to encourage granulations. Any of these should be removed by fine curved scissors, a small curette (with the help of eucaine), pure carbolic acid, silver nitrate, chromic acid, &c. As long as the least discharge or smell from the meatus can be detected, the patient or friends must be made to understand that, though he has been brought back from the edge of a precipice, he is still not very far from the brink.

Mr. Ballance (*loc. supra cit.*) adopted a different plan of after-treatment, which, when successful, is superior to the above in point of time, and in saving patient and surgeon the repeated pluggings—a point of much importance in hospital patients and those who are timid. Ten, fourteen, or twenty-one days after the first operation, he covers in all the exposed bone by means of grafts taken by Thiersch's method (p. 233). But if any disease be left, or if caries, as a result of operation-injury, follow, this method will fail. Mr. Ballance's first departure from the ordinary treatment concerns the cartilaginous canal. Being dissatisfied with the flap method, owing to the difficulty met with in keeping the flaps in place, he pursues the method illustrated in Figs. 114 to 118.

Before the curved wound on the mastoid is sutured, the bony cavity is thoroughly cleansed, dried, and plugged with a narrow strip of iodoform gauze carefully packed against the inner wall of the antrum, attic, and tympanum, the end being brought out through the enlarged meatus. This is changed as often as needed in the interval between the two operations. At the end of a week the stitches uniting the curved skin wound will have been removed, but the deep threads holding the meatal flap in position should be left *in situ* as long as possible.

FIG. 115.

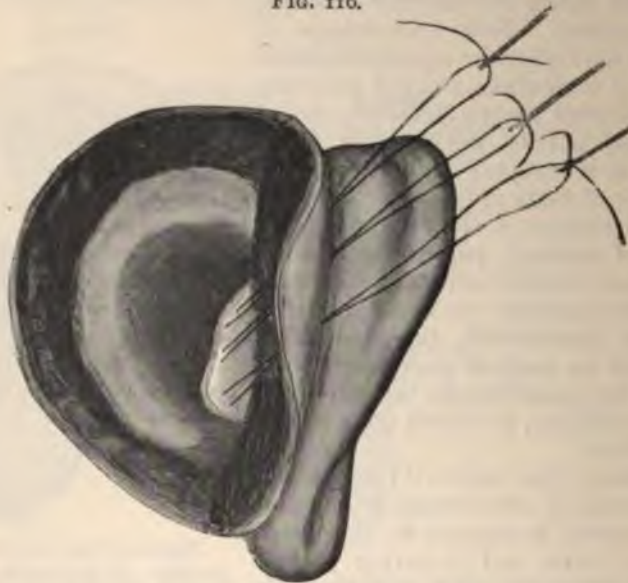


The white line here shows the direction of the incision in the concha. The knife is first carried through the concha backwards, and then backwards and upwards till the anterior extremity of the helix is reached. (Ballance.)

Mr. Ballance's second and most important improvement—*i.e.*, the grafting of the bony cavity—is performed as follows:—Ten, fourteen, or twenty-one days after the first operation, on the morning of the second operation the cavity is washed out with warm sterile saline solution; and this is the only fluid which is used at this operation.

The anæsthetic having been given, the original incision is opened up, and the pinna displaced forwards as in the first operation. All oozing must be arrested with dry sterilised gauze, or the approximation of the graft to the bone will be prevented. A graft is next cut, as thin as possible, in the usual way (p. 234). If practicable, one large enough to

FIG. 116.



The concho-meatal flap is seen behind the mastoid flap. Supporting stitches (one, two, or three, as the case may be) are carried through the edge of the conchal cartilage. The two threads of each stitch are now threaded on one needle, so that they can be passed through the skin and other tissues of the mastoid flap without constricting them. Before the supporting stitches are passed the thick layer of tissue behind the posterior wall of the meatus is cut away so as to facilitate the application of the meatal to the skin flap. (Ballance.)

cover the whole granulating bony area should be employed. It is best carried to the wound on one of Mr. Ballance's microscopic section-lifters. When the graft, or grafts, have been, by careful manipulation, worked from before backwards, so as to cover and lie flat against the area of the first operation, blood or bubbles of air must be removed by tiny moist pledgets, or the use of Mr. Ballance's steel "stoppers" with pear-shaped heads will greatly facilitate the perfect approximation between the graft and the bony surface. As a protective to the grafts, Mr. Ballance prefers gold-leaf. This is carefully pushed into position, and the cavity plugged with a strip of sterilised iodoform gauze. A week later this is removed, and in another three or four days the gold-leaf is taken out with forceps, aided by gentle irrigation. A little dry sterilised gauze

is packed in against the graft, to be changed every two or three days until the healing process is complete. The cases in which this and other methods fail to secure early and sound healing are chiefly explained (α) by some infective material being left behind; (β) by the bony surface left being irregular from faulty smoothing. Against such a surface the delicate grafts may easily perish.

ABSCESS IN THE BRAIN OR CEREBELLUM.—(A) When in the brain, the collection of pus is usually in the middle and back part of the temporo-sphenoidal lobe; (B) when in the cerebellum, in the front and outer part of the lateral lobe.

Symptoms.—These are often rather negative,* no special nerve symptoms being called out in the above regions, as is the case with an abscess in the motor area. They are often masked by the co-existence of other complications of otitis media. "Abscess in the brain may be latent, producing no symptoms directly referable to the brain, only general symptoms of ill health, until excited to activity by a blow, or some minor operation, such as the removal of a polypus" (Ballance). Such latent abscesses possess a well-marked capsule. This is of two-fold importance. It prevents the risk of rupture and, as will be seen later, it may baffle attempts to find the pus. On the other hand a rapidly enlarging abscess is very likely to rupture into a lateral ventricle, and the more acute the abscess the more will it be accompanied by an advancing infection of the surrounding brain. This condition, by causing such symptoms as a high temperature and delirium, will be an additional cause of the masking of the typical symptoms of cerebral abscess. By leading to a diagnosis of meningitis, they may cause the abscess to be overlooked. There is a history, perhaps, of mastoid suppuration, with the symptoms given above, unrelieved by treatment. An earlier period, in which headache, vomiting, and a dull, heavy mental state are usually present, is followed by a more urgent stage. Amongst the most important

FIG. 117.



The supporting stitches are shown drawn tight, and supporting the raw surface of the conchomeatal flap against the raw surface of the mastoid flap. (Ballance.)

* Dr. Collins, of New York, in an interesting review (*Amer. Journ. Med. Sci.*, April 1899) of the recent literature of the treatment of abscess of the brain, concludes that "the literary records of each succeeding year show that the mortality-rate of abscess of the brain has not fallen as it should have done. This result may be attributed to two factors: first, to lack of early recognition of the disease, apart from its localisation; and, second, to the fact that surgeons are oftentimes not sufficiently assiduous in their search for it."

symptoms of this are agonising headache;* drowsiness, deepening into coma; while power of speech remains, the answers are unwillingly given, delayed, but intelligent; "sluggish but perfect cerebration" (Barker, *Lancet*, 1887, vol. i. p. 1177); vomiting (this is occasional, or ceases after a day or two), not constant and incessant; one or two rigors may occur at the commencement of the abscess formation, but they are not commonly repeated in an uncomplicated case of abscess; the temperature is rarely high in cases uncomplicated with meningitis or thrombosis, often subnormal—*e.g.*, 97°, and falling; the pulse slow—*e.g.*, 65—50; optic neuritis;† progressive emaciation; obstinate constipation. Monoplegia, or paresis of the centres of the upper extremity, paralysis of face, ptosis, alteration of pupil, are either absent, or slightly marked and difficult to detect in the condition of the patient. Their presence must depend in part how far an abscess has extended forwards in the temporo-sphenoidal lobe sufficiently to press upon the lower convolutions of the motor area and the cavernous sinus lying on the inner aspect of the anterior end of the lobe. The following symptoms are most grave, and point to a fatal termination being not long delayed—*viz.*, lividity, irregular pulse, tracheal râles, pulmonary crepitation, incontinence of excreta, tremors, cervical swelling along the internal jugular vein (p. 311), and, of course, evidence of pyæmia or meningitis, these conditions often co-existing.

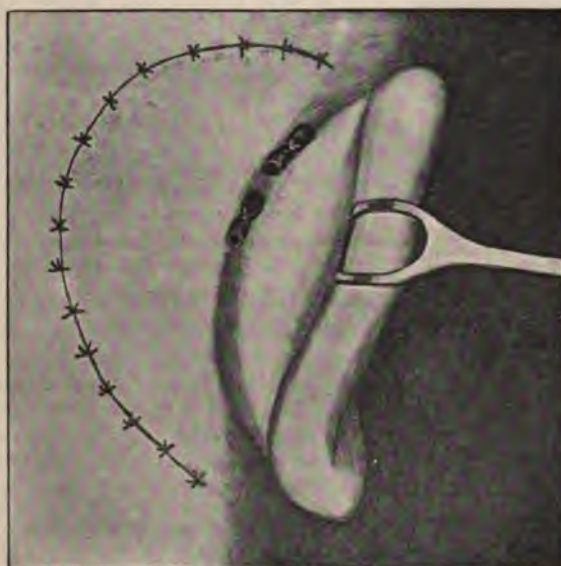
Abscess in the Cerebellum.—While the symptoms common to cerebral and cerebellar abscess have been recognised for several years, those peculiar to abscess in the cerebellum have been much less clearly defined. Surgeons have received great help here from an elaborate article by Dr. T. D. Acland and Mr. Ballance (*St. Thomas's Hosp. Rep.*, vol. xxiii. p. 133). The writers throw doubt upon the opinion usually held, that abscess in the temporo-sphenoidal lobe is more common than in the cerebellum. They quote Körner's statistics (*Arch. f. Ohrenheilkunde*, Bd. xxix. 1890, S. 16), showing that in 100 cases of abscess of the brain, secondary to ear disease, 62 were in the cerebellum and 32 in the cerebrum, and 6 in both cerebrum and cerebellum. Of 33 cases collected from the St. Thomas's and the Great Ormond Street Hospitals, 24 were cerebellar and 11 temporo-sphenoidal abscesses. In two cases

* Dr. Pitt (*loc. supra cit.*) considers that the two most characteristic symptoms are "a headache of intense severity, and a dull, sluggish mental state."

† It seems at present unsettled to what condition, thrombosis, meningitis, &c., this symptom is chiefly due. While optic neuritis is certainly met with in abscess, meningitis, and thrombosis, it may be present in mastoid inflammation without any cerebral abscess or other known complication save otitis media, and may persist for a long time after the case has been successfully treated by operation; this occurred very markedly in a case which I was asked to operate by Dr. F. Taylor in his wards at Guy's Hospital. Another point is, I think, certain—that if optic neuritis persists after a cerebral abscess has been opened and all seems to be doing well, it is evidence that the cavity is not completely drained. Persistence of the neuritis was a very marked feature in the case mentioned later, in which, after trephining and finding a very large temporo-sphenoidal abscess, I had on two occasions, many weeks subsequently, to let out re-collections of pus. Here it was not until long after the first operation, the wound being now healed, and the patient for some time up and about to leave the hospital, that Dr. Goodall, the medical registrar, reported, "On Aug. 2 (five and a half months after the first operation) there was a little indistinctness of the inner edge of the right disc (the abscess had been on the left side), otherwise both discs were normal."

an abscess was present both in the temporo-sphenoidal lobe and in the cerebellum. In 20 cases the abscess was on the right side, and in 13 on the left (footnote, p. 287). Dr. Acland and Mr. Ballance drew attention to the fact that in their case certain symptoms were present which so closely resembled the effects produced by removal of one lateral lobe of the cerebellum, that they deserve to be fully considered. These are: i. Paralysis of the upper extremity on the same side as the lesion. ii. Conjugate deviation of the eyes towards the opposite side. iii. Lateral nystagmus. iv. Exaggerated knee-jerk on the same side as the cerebellar lesion. v. A tendency to face towards

FIG. 118.



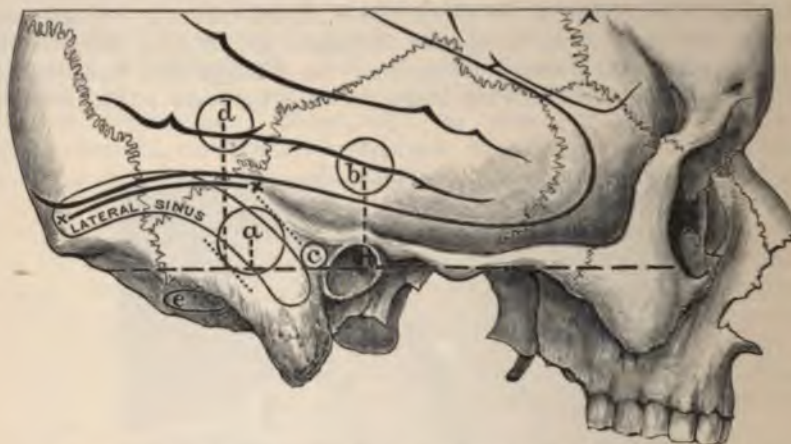
The supporting stitches are shown passing through the angle of junction of the pinna and the mastoid flap. They were two in number in the case from which the drawing was made. They are tied over pieces of rubber tubing. This is shown too small, and the threads are tied too tightly. The curved incision is entirely closed by gossamer silkworm-gut sutures. (Ballance.)

the side of the lesion in walking. vi. Staggering gait, and a tendency to fall towards the side opposite the lesion. vii. Attitude in bed: the patient tends to lie on the side opposite to the lesion with the limbs flexed, and with the side of the face corresponding to the lesion uppermost. The diagnosis of cerebellar abscess is dealt with in the fullest and most helpful way, and the paper deserves the most careful study. Time only will show to how many cases the above-given localising evidence of cerebellar abscess applies, and how far such indications may be further modified by the site, size, and duration of the abscess.*

* Dr. J. Mitchell Clarke and Mr. Morton (*Bristol Med. Chir. Rev.*, vol. xix., No. 72, p. 112) state that in their case of cerebellar abscess successfully evacuated the clinical symptoms closely corresponded with those given by the authors of the above paper. In three cases of cerebellar abscess published by Dr. Green, Professor of Otology at

Sir W. Macewen (*loc. supra cit.*, p. 196) draws attention to the fact that in cases of pressure in the cerebellar fossa, implicating the medullary respiratory centre, the respiration may be gravely imperilled. Further, that cerebellar abscess may cause great ventricular distension

FIG. 119.



The figure shows the relations of the lateral sinus to the outer wall of the skull, and the position of the trephine-opening, a, for exploring it. Reid's base-line is shown passing through the middle of the external auditory meatus and touching the lower margin of the orbit. x x indicate the site of the tentorium as far as it is in relation to the outer wall of the skull. The anterior x shows the point where the tentorium leaves the skull and is attached to the upper border of the petrous bone. a, Trephine-opening to expose lateral sinus, its centre being 1 inch behind and $\frac{1}{4}$ inch above the centre of the meatus. This opening can easily be enlarged upwards, backwards, downwards, and forwards (see the dotted lines), by suitable angular forceps. It is always well to extend it forwards so as to open up the mastoid antrum, c. b, Trephine-opening to explore the anterior surface of the petrous bone, the roof of the tympanum, and the petro-squamous fissure, its centre being situated a short inch above the centre of the meatus. At the lower margin of this trephine-opening a probe can be insinuated between the dura and the bone, and made to search the whole of the anterior surface of the petrous. c, Trephine-opening for exposing antrum, $\frac{1}{4}$ inch above and behind the centre of the meatus. d, Trephine-opening for temporo-sphenoidal abscess (Barker), $1\frac{1}{4}$ inch behind and above centre of meatus. The needle should be directed at first inwards, and a little downwards and forwards. e, Trephine-opening for cerebellar abscess, $1\frac{1}{2}$ inch behind and 1 inch below the meatus. The anterior border of the trephine should be just under cover of the posterior border of the mastoid process. Such an opening is well removed from the lateral sinus, and a needle, if directed forwards, inwards, and upwards, would enter an abscess occupying the anterior portion of the lateral lobe of the cerebellum, the usual site of an abscess in this part of the brain. (Barker.)

College (*Amer. Journ. Med. Sci.*, April 1899), paralysis of the extremities was absent in all, and it is stated that "in all of the cases an accurate diagnosis before operation was absolutely impossible." Those interested in this difficult question of diagnosis of cerebellar disease should refer to a masterly paper by Dr. A. Bruce, of Edinburgh, "On the Localisation and Symptoms of Disease of the Cerebellum, considered in Relation to its Anatomical Connections" (*Brit. Med. Journ.*, vol. i, 1899, p. 1079).

and accompanying œdema. A little increase in the above conditions—*e.g.*, when an anæsthetic is given—may easily bring about a fatal result.

Where the diagnosis between a cerebral and a cerebellar abscess still remains doubtful, the only point that should guide us is this: if there is reason to believe that an abscess exists in the brain, the surgeon, on failing to find pus in the temporo-sphenoidal lobe, should not allow the patient to die without exploring the corresponding lobe of the cerebellum.

A. Steps of the Operation of Trephining for Temporo-sphenoidal Abscess.—Any opening in the antrum and the tympanum having been rendered as aseptic as possible, the side of the head having been shaved and sterilised, a semilunar flap of appropriate size is turned up, and the hæmorrhage arrested by Spencer Wells's forceps. Figs. 119 and 120 show the different sites for applying the trephine for a cerebral or a cerebellar abscess.

Mr. Ballance: "The application of the point of the trephine should be about $\frac{7}{8}$ inch above the suprameatal spine, the object being to expose the lowest part of the middle fossa just external to the tegmen auri and tegmen tympani. Immediately above the tegmina are the tissues in which, as a rule, the infective process first develops."

Sir W. Macewen gives the following as the rule for exploring a temporo-sphenoidal abscess:—"The centre-pin of the trephine is placed in a line with the posterior wall of the meatus, and $\frac{3}{4}$ inch above the posterior roof of the zygoma." Mr. Barker (*Brit. Med. Journ.*, Dec. 11, 1886) thinks that nine-tenths of abscesses in the brain are within a circle with a $\frac{3}{4}$ -inch radius, whose centre lies $1\frac{1}{4}$ inch above and the same distance behind the centre of the bony meatus. Either of the two methods first given will give better drainage and is to be preferred. The crown removed cautiously, according to the directions given at p. 252, should not show any of the groove for the lateral sinus, nor, if possible, any middle meningeal branch. If the latter is in the way, crossing the dura mater, it should be secured between two catgut ligatures. The opening in the bone is next freely enlarged, until it measures at least $1\frac{1}{2}$ inches transversely by 1 inch vertically. The dura mater, if the abscess be of any size, will now bulge forward without pulsation. Sir W. Macewen points out, however, that "a small abscess may exist at a deeper level without any diminution of the cerebral pulsation."*

* In some cases the presence of a temporo-sphenoidal abscess has been detected during an operation on the antrum by the presence of a perforation in the roof of this cavity (p. 297), which communicates with the abscess. An abscess thus detected has been occasionally drained by enlarging the opening and dilating the abscess track. Such drainage from the antrum is liable to be inadequate, especially in large abscesses of rapid growth and without well-defined walls. A second opening should be made into the abscess higher up, in the usual way, and a tube introduced here also. The abscess can then be washed out from the upper to the lower opening. Some surgeons, with especial experience of aural surgery, are in the habit of opening temporo-sphenoidal abscess through the tegmen tympani. Having myself had experience of both methods, I am convinced that for the majority of my readers who are without that especial experience which can only be possessed by very few, exploration through the side of the skull is the simpler and safer method. The tegmen tympani route gives excellent drainage and is most satisfactory

Before opening the dura the cut bone surfaces around and the membranes beneath should be protected by rubbing in sterilised iodoform and with gauze before any infective pus is withdrawn. The dura should be opened by a crucial incision as a flap may interfere with free drainage. To render easier the securing of any cut vessels, a small aperture is first made in the centre by incising the membrane gradually with a knife, the opening is then completed by cutting with fine blunt-pointed scissors. Two points must be now remembered. Owing to the intracranial tension the vessels of the cortex will be forced closely against the membranes, and if there has been any meningitis the membranes will be fused to each other and to the brain. (Macewen.)

With regard to the three instruments usually employed for the detection of an abscess, the following practical hints are given by the same authority:—"If a hollow needle without a stylet, such as some of those used with an aspirator, be introduced, it will cut the brain substance and become occluded, and if the pressure inside the abscess be small, the occluding brain substance may not be forced out of the hollow needle, and consequently any pus may be prevented from escaping. It is possible that the abscess cavity may be missed if attention be not directed to this point. The introduction of a trocar and cannula will obviate this difficulty, but while being inserted it is liable to transfix a small abscess without revealing the pus, unless the trocar be removed once for each quarter of an inch of brain tissue penetrated. When the sinus-forceps are used the blades are several times gently expanded as they are introduced. The instrument used ought to be inserted in an inward, downward, and slightly forward direction, so as to impinge, if it went far enough, against the cranial aspect of the tegmen tympani. While the instrument is being inserted, a *slight* to-and-fro lateral movement ought to be imparted to its point, with the view of ascertaining whether it has entered a cavity, inside which its extremity can move without resistance." In cases of difficulty my own experience would lead me to prefer a narrow-bladed knife or straight bistoury to any needle.

The following is an excellent instance of the thickness of the wall of a cerebral abscess.

A child, *æt.* 5, with long-standing mastoid disease, was under the care of Mr. P. Paterson at the Glasgow Royal Infirmary (*Lancet*, Jan. 28, 1905). A large erosion had been found in the tegmen tympani, and on exploring the temporo-sphenoidal lobe, the membranes (which pulsated) were incised, and a hollow needle introduced into the cerebral substance. At a depth of three-quarters of an inch, the instrument came in contact with a firm resisting mass. The size of the tumour was ascertained by passing the needle in various directions, but steady and fairly firm pressure failed to make it penetrate the substance. A solid tumour, probably tuberculous, with lepto-meningitis, was diagnosed, and as the mass seemed too large and too deeply situated for removal, the patient was put back to bed. Death took place five hours later. At the necropsy a temporo-sphenoidal abscess with very thick walls and of very long duration was found. It contained thick, creamy pus. Even after removal considerable force was required to penetrate it.

if a temporo-sphenoidal abscess be struck at once. But where an abscess is small, or possesses thick walls the limited space given by the tegmen route renders this path less satisfactory.

The difficulty met with in this case supports my view that a narrow bistoury is often superior to a needle. However this may be, the candid publication of such cases is most praiseworthy, and quite as helpful as that of many successful ones.

Since writing the above I find that Mr. Ballance adds the weight of his authority to the use of the knife, and to the enucleation of cerebral abscesses in those cases, a minority, in which a capsule is present. The two following cases quoted by him are most instructive; it will be seen how closely the first resembles that of Mr. Paterson.

Mr. Ballance had been called to a case of cerebral abscess in which coma had supervened, and artificial respiration was being performed on his arrival. When the bone had been freely removed "the brain bulged under great pressure, but natural respiration did not return. A trocar and cannula were plunged in up to the hilt and impinged upon a hard mass which it did not penetrate. As this was thought to be a solid basal tumour which could not be removed the operation was abandoned. The necropsy revealed an encapsuled abscess containing an ounce of thick green pus, replacing the right optic thalamus. The capsule was very firm, and quite one-eighth of an inch thick. This abscess might have been enucleated had it been recognised.

The second case was under the care of Mr. Abbott (*St. Thomas's Hosp. Rep.*, vol. xxv. p. 205).

"The brain was explored in various directions with a trocar and cannula with a negative result. At the necropsy there was found a large abscess with very thick walls containing over four ounces of green offensive pus. So thick was the wall that the abscess shelled out whole and could be rolled about the table. In fact it needed a sharp plunge with the knife to open it."

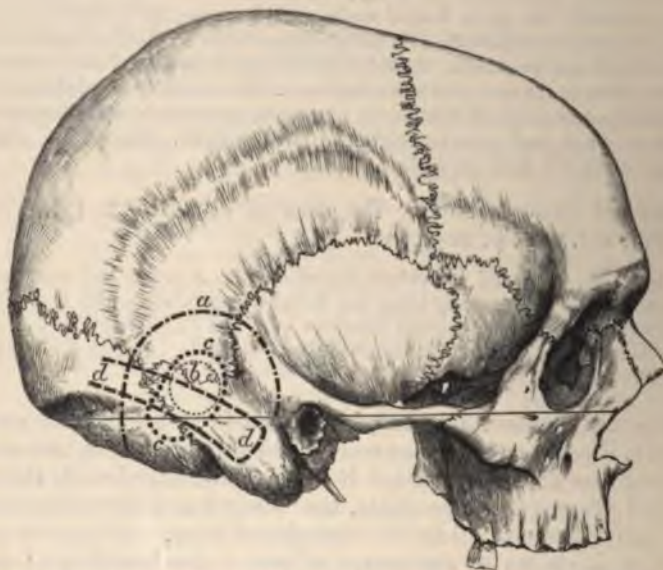
The pus having been detected, it remains to empty the abscess cavity completely, if enucleation is not considered feasible. The rate at which the abscess has formed, whether it has a well-marked wall, the degree of infection present in its contents, the number and size of any sloughs of brain substance, are all to be remembered here. When the abscess is struck, as is shown by the escape of pus or the bubbling of gas, the opening is enlarged by a small scalpel or by inserting sinus-forceps and opening them. Any sloughs that appear are drawn away, and if the pus is very foul the abscess cavity may be very carefully irrigated with gentle pressure, but only after two drainage-tubes have been inserted, sterile saline solution or boiled water being introduced very gently by one tube and allowed to flow out by the other. As soon as the returning fluid is clear, irrigation should be stopped. Where there are no facilities for irrigation, emulsion of iodoform and glycerine may be injected. Whether tubes of decalcified bone or the ordinary india-rubber ones are made use of, the inner end should be safely lodged just within the abscess, and no more, while the outer one should be secured to the flap, and this so arranged as not to interfere with free drainage. The flaps of the dura should not be too closely stitched together in any case, and where the pus is foul the flaps should be reflected and iodoform gauze wrung out of carbolic acid (1 in 20) should be carefully packed around the opening, to prevent infection of the membranes.

In some cases where the abscess is large, where sloughs are present, or the pus very thick, much difficulty may be experienced in draining the abscess and in securing its complete obliteration. This is usually due to the drainage-tube being removed too soon. If an india-rubber tube

has been employed, this should be replaced at the end of thirty-six or forty-eight hours by a decalcified bone tube; and it may be advisable to employ a series of these, introduced at shorter or longer intervals according to the amount of infection present, over a period of two or three weeks, in a large abscess (*vide infra*), especially in one with thick walls.

Recurrence of Symptoms.—This is not uncommon in the first few days after a cerebral abscess has been opened. It may be due to faulty drainage, to infective cerebritis around the original abscess, to meningitis, or to a second abscess being present in another part of the same

FIG. 120.



Mr. Dean's method of exposing the chief intracranial complications of chronic otitis media.

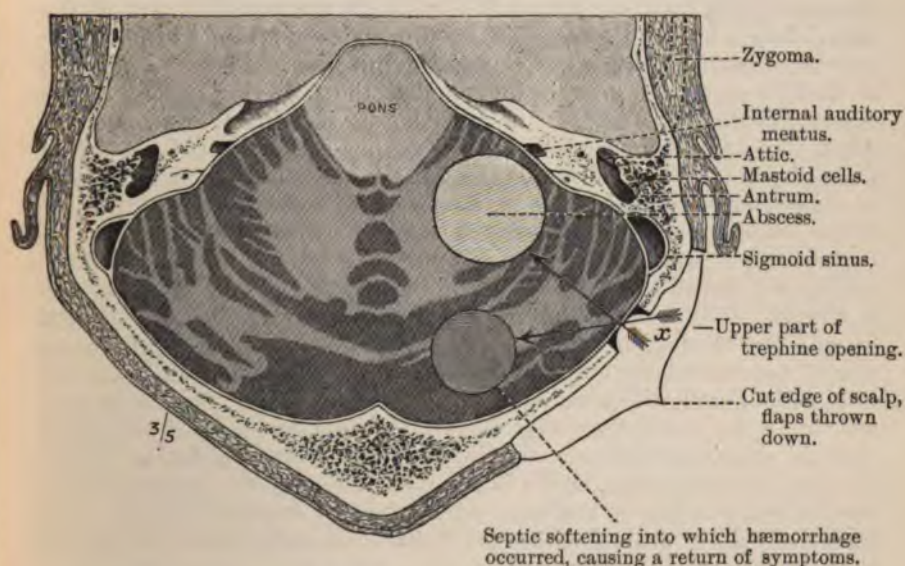
a, Line of skin incision. A semicircular flap commencing just behind the pinna, and having a diameter measuring about 2 inches. *b*, Pin of trephine placed $1\frac{1}{4}$ inches behind, and $\frac{1}{4}$ inch above the centre of the external auditory meatus. *c*, Area of bone removed by bone-forceps, exposing the lateral sinus completely, and the dura mater above and below it, so as to admit of exploration both of the temporo-sphenoidal lobe and the cerebellum. *d*, Outline of the lateral sinus.

lobe or in the cerebellum. "In the cerebellum it is by no means infrequent to have a second or third abscess" (Ballance). This authority illustrates the truth of the above by two cases related in his article on "Certain Affections of the Ear" (Allbutt's "System of Medicine.") "In one of these one cerebellar abscess, and in the other two, had been opened, yet both patients died from an unopened abscess, oyster-like in shape, lying immediately beneath the cortex of the upper surface of the cerebellar hemisphere. The examining finger felt the sensation of resistance, but this was attributed to the tentorium."

To save the risk of serious shock from a second operation, and perhaps a fatal result in an exhausted patient, the surgeon, when in doubt as to

the extent of the mischief and the region in which an abscess is situated, should avail himself of the plan recommended by Mr. H. P. Dean (*Lancet*, 1892, vol. ii. p. 250), by which with one flap and one trephine-hole the temporo-sphenoidal lobe, the cerebellum, and the lateral sinus can all be explored (Fig. 120). A semicircular flap of skin just above and behind the ear is turned down, and a periosteal flap then reflected, this flap having a diameter of about 2 inches. The antrum is explored in the usual way, if this has not been already done, the pinna being detached and pushed well forwards. The pin of the trephine is placed $1\frac{1}{4}$ inches behind and $\frac{1}{2}$ inch above the centre of the external auditory meatus, and a disc of bone $\frac{3}{4}$ inch in diameter removed. The lateral

FIG. 121.



Dr. Acland and Mr. Ballance's case of cerebellar abscess, secondary to otitis media suppurativa, successfully dealt with by trephining. (*St. Thomas's Hosp. Rep.*, vol. xxiii. pl. 1).

sinus is exposed in the lower part, and the dura mater above, probably bulging considerably. The temporo-sphenoidal lobe can be explored from the upper, and the sinus from the lower part of the trephine-hole. The cerebellum can be next examined by removing the bone backwards and downwards for $\frac{1}{2}$ inch with Hoffmann's forceps, this step exposing the whole diameter of the lateral sinus and the dura mater below it. The latter is then incised and the cerebellum explored by the means given at pp. 306, 310.

Another extremely simple and efficient method of exposing the different areas, antrum in front, lateral sinus and cerebellum behind, and temporo-sphenoidal lobe above, is to begin by the usual curved incision behind the auricle: a horizontal incision carried backwards at an angle to the lower part will enable the lateral sinus and cerebellum to be explored, while a vertical one carried upwards at a right

the upper part of the curved incision will expose the bone over an abscess in the temporo-sphenoidal lobe. Usually any mastoid trouble will have been already operated upon. Where this is not the case, and the symptoms of abscess are urgent, this will, of course, be dealt with, and a Stäcke's operation deferred to another time.

B. Operation of Trephining for an Abscess in the Cerebellum.—Mr. Barker (Fig. 119) advises a point $1\frac{1}{2}$ inch behind the centre of the meatus and 1 inch below the base-line ("a line running from the lower border of the orbit backwards through the centre of the meatus"—Reid). This point is well behind the vertical, and well below the horizontal part of the lateral sinus, while it gives access to all the anterior third of the lateral lobe, in which the pus is usually found. Mr. Ballance (*St. Thomas's Hosp. Rep., loc. supra cit.*) writes: "A cerebellar abscess arising from ear disease is usually in the anterior part of the lateral lobe, close to the bone disease (inner side of mastoid or posterior surface of petrous) which has caused the infection. Place the trephine so that its anterior border is just behind the posterior border of the mastoid process, and so that its upper border is below Reid's base-line. After the dura is opened the trocar or pus-seeker should be passed forwards, upwards, and inwards through the cerebellum in the direction of the posterior surface of the petrous bone. Thus an abscess situated in the anterior and outer part of the hemisphere will be evacuated. If the abscess is in the anterior and inner part of the lobe the cannula will have to travel quite two inches inwards from the surface before pus is struck. It is probable that in many instances an abscess has not been opened, and the patient's life lost, because the surgeon has hesitated to plunge the cannula in far enough. In abscess of the flocculus, pus will have to be found still more deeply." The same writer points out that abscess in the cerebellum may be due to infection from a sloughing sigmoid sinus, and not from the disease of the temporal bone. When a second abscess forms, which is not uncommon in the cerebellum, it should be looked for on the inner side of the first or posterior to it. For further details in dealing with a cerebellar abscess the reader is referred to those already given at p. 306.

In three successful cases I had no difficulty whatever in finding the abscess, but it was by no means equally easy to feel sure that the drainage-tube was properly inserted and retained in the abscess cavity.

In one case of temporo-sphenoidal abscess, which ultimately made an excellent recovery, I was unable, thirty-six hours after the trephining (Feb. 20), to satisfy myself that the tube, though still *in situ*, reached the abscess. As there was a great tendency to blocking of the tube, owing to the thickness of the pus and the amount of brain detritus present, it was not stitched, so as to allow of daily removal and cleansing. All did well for a fortnight, save that the temperature tended to remain subnormal. Then headache returned, and on March 10 I inserted a scalpel along the track of the tube, giving vent to thick, green, sweet pus. A larger drainage-tube was inserted and stitched to the flap, which was partly cut away to facilitate drainage. There was the same tendency for the drainage-tube to get blocked, and a fresh collection again took place, with return of headache. On May 1, I again evacuated from three to four ounces of pus, operating now through a hernia cerebri the size of a walnut. This was clipped away with scissors. After this third operation the patient made an excellent recovery. The hernia cerebri was cured by the constant pressure of a leaden plate notched for the drainage tube. This was kept in place by the unremitting attention of my dresser, Mr. Meadows-Turner. A hernia cerebri may of course be an indication that the abscess is imperfectly drained, or that a second one is present.

Where this is not the case, the constant, even, uniform pressure of a lead plate, which can be sterilised by boiling, will be found most efficient.

In the second case, a cerebellar abscess also due to right-sided otitis media,* the pus was expelled under very high tension through the exploring cannula, and the abscess promptly emptied at once. The cavity closed and the wound healed rapidly.

In the third, a case of a frontal abscess in a girl, secondary, after some months, to a fall upon the nose, the patient was, without my knowledge, discharged with a small and apparently trivial sinus. This became infected and the symptoms of abscess reappeared. The case was finally cured after re-opening the abscess and the use of decalcified bone tubes.

I have introduced this case here partly to emphasise the need of complete drainage and thorough obliteration of a cerebral abscess, but also to call my reader's attention to the variety of cerebral abscess, which is rather liable to be overlooked, on account of the frontal lobe being often "a silent area," and the greater prominence which abscesses due to otitis media have received. Cerebral abscess of nasal origin may follow disease in the upper nose, or its associated cavities. This may be brought about by direct involvement of the bones, or by extension along the blood vessels and lymphatics. Meningitis and thrombosis, usually of the cavernous sinus, are other complications of infection of nasal origin, alone, or in combination with a cerebral abscess. As a considerable portion of one frontal lobe may be destroyed without any marked especial symptoms the following advice of v. Bergmann (*loc. supra cit.*, p. 288), is much to the point. "General symptoms following upon a suppurative wound or an empyema of the frontal sinuses will often suggest a cerebral abscess. For example, a person is shot in the forehead and the bullet cannot be found. The first symptoms of swelling and fever subside, and suppuration continues from a fistula for months, when suddenly headache, evening dulness, choked disc, &c., develop. A frontal abscess should be suspected, especially if the patient is restless and repeatedly vomits, although the stomach is empty." My space only allows me to allude to those forms of metastatic abscess, *e.g.*, secondary to intra-thoracic mischief, especially such as long standing empyema, gangrene of the lung, &c.

It cannot be too strongly laid down that until the wound is soundly healed the patient is not to be allowed out of bed, still less to leave the hospital, however trivial appears the wound which still has to heal. The use of the drainage-tube and the administration of only light diet will often be needed for two or three weeks, and if there is any delay or doubt about the final healing the patient should be kept quiet in bed for another two or three weeks.

INFECTION OF SINUSES.—The following remarks refer to infection of the lateral sinus, especially thrombosis. This is a grave lesion, from its tendency to cause general pyæmia and distant suppurations. When the mischief is limited to this sinus, as is usually the case in the earlier stages, much hope may be placed in operative interference. Sir V. Horsley (*Clin. Soc. Trans.*, vol. xix. p. 290) first in this country suggested ligation of the internal jugular in these cases, and Mr. Lane (*ibid.*, vol. xxii. p. 262) first adopted this step with success, with the objects of securing more thorough removal of the septic thrombus from the sinus, and to

* This patient was admitted in a state of insensibility and moribund; no anæsthetic was used.

obviate the passage of septic material or antiseptic injections into the circulation. In the *Lancet* (vol. i. 1890, pp. 1057, 1114) is a most instructive paper by Mr. Ballance, who had then operated in four cases, in two successfully. Where the mischief, in rarer cases, has extended from the lateral to the other sinuses, *e.g.*, by the petrosal to the cavernous sinus, interference will be hopeless.* It occasionally happens that the primary seat of the thrombosis is in the superior petrosal, not in the lateral sinus.

Mr. Ballance (*loc. supra cit.*) believes that the following group of symptoms, when present together, are pathognomonic of septic thrombosis:—1. A history of purulent discharge from the ear for a period of more than a year. 2. The sudden onset of the illness, with headache, vomiting, rigor, and pain in the affected ear. 3. An oscillating temperature. 4. Vomiting, repeated day by day. 5. A second, third, or more rigors. 6. Local œdema and tenderness over the mastoid,† or in the course of the internal jugular.‡ 7. Tenderness on deep pressure at the posterior border of the mastoid and below the external occipital protuberance. 8. Stiffness of the muscles of the back or side of the neck. 9. Optic neuritis.

Dr. Schlatter (v. Bergmann's *Syst. of Pract. Surg.*, p. 293) states that jaundice is frequently observed, occurring three times as often in pure sinus-phlebitis as in the complicated form. In all cases enlargement of the liver was found. Swelling of the spleen is always present. Convulsions are rarely present in pure sinus-phlebitis. In the complicated form they occur three times as frequently, and most frequently when complicated by cerebral abscess. In marked contradistinction to cerebral abscess, the activity of the brain is not impaired in uncomplicated infective thrombosis, the intelligence of the patient being retained almost to the end. The last statement requires, I think, some qualification according to the degree of toxæmia present.

Dr. Schlatter, in his minutely careful article, describes three types which the course of this disease may take. (a) Pulmonary, much the most frequent, Hessler having shown that in 130 cases of sinus-phlebitis with metastases, the lungs were found unaffected only 14 times; (b) Abdominal, the toxæmia here causing typhoid fever-like symptoms; (c) Meningeal.

The treatment of these cases must, in Mr. Ballance's words, "be twofold—viz., the free exposure and removal of the focus from which the pyæmic infection has occurred or is threatening; and, secondly, the establishment of a block in the highway along which the infecting agents are travelling from the local focus into the general circulation."||

Mr. Ballance in a more recent communication (*Lancet*, Sept. 20,

* Mr. Sheild (*Diseases of the Ear*, p. 176) gives an instructive case of this kind. Here the eyeballs protruded owing to the thrombosis of the cavernous sinuses. Sir W. Macewen, in that storehouse of valuable information, *Pyogenic Diseases of Brain and Spinal Cord* (Figs. 53, 54, 55, pp. 248, 249), figures such a case.

† Absence of these points may be explained by sclerosing osteitis of the mastoid, and in rare instances, Mr. Ballance thinks, by absence of the occipital vein.

‡ Œdema or tenderness over the internal jugular are due to extension of the clotting, and phlebitis, or to enlargement of the deep lymphatic glands. Any examination of the internal jugular should be conducted with the utmost gentleness for fear of detaching thrombi. And the same risk accompanies every movement of the head.

|| "Whenever the mastoid vein, which perforates $1\frac{1}{4}$ inch behind the meatus, and on a level with it, is found thrombosed, the sinus should be explored" (Pitt, *loc. supra cit.*).

1904, and Manchester meeting of the British Medical Association, Aug. 1, 1902) advises that the internal jugular should be operated upon, and removal is better than ligature—(1) in acute pyæmia and septicæmia, whether the sinus is occupied by a clot or by fluid blood; (2) if the sinus is gangrenous, or its contents are putrefying; (3) if it is known or suspected that the blood in the jugular bulb is in part or wholly clotted; (4) if the jugular vein is thrombosed. The operation on the vein should precede that on the temporal bone. After dealing with the vein the sinus should be thoroughly exposed by removal of bone for a distance of at least three-quarters of an inch beyond the area of inflammatory change. The freest exposure of the sinus is required. The method of curetting away putrefying clot through a small opening in the sinus is one which should be abolished from surgery. The sinus should be slit up, if necessary, from bulb to torcular. The surgeon must decide before or during the operation whether the patient is suffering from an acute systemic infection or from a systemic disturbance depending upon a local process.

The following are the chief steps in the operation required. To begin with, if, as is often the case, sinus infection is complicated by cerebral abscess—and the manifestations of the one may easily mask those of the other—and the surgeon is in doubt which to operate on first, sinus infection is certainly the most urgent, and also, usually, the first to develop. Before dealing with the cerebral abscess the instruments used at the first operation should, of course, be resterilised. An incision in the line of the carotid sheath having exposed the jugular vein, if this vessel be not thrombosed it should be divided between two ligatures* at the level of the cricoid cartilage and removed, after ligature of its branches completely up to the bulb. If the vessel be thrombosed its removal should commence at its junction with the subclavian. Having dealt with the vein the operator exposes the region of the sinus by appropriate flaps (p. 309), and “removes bone† so as to expose the sinus towards the torcular for a distance of at least three-quarters of an inch beyond the area of inflammatory change; and the same treatment is adopted on the other side of the inflamed area, bone being removed, in some cases at least, as far as the bulb, so that the whole area of possible infection of sinus and vein is exposed in one continuous wound. If one continuous wound is not made in cases of lateral sinus pyæmia the dangerous area of the bulb is not laid open,

* I repeat that if in doubt the surgeon should tie the vein. It adds very little to the patient's risks. After ligature of the vein, pyæmic deposits may still take place by means of the posterior condyloid or some unnamed vein. In one of Mr. Ballance's cases, in which the vein was thrombosed, there was some difficulty in identifying it, as it was collapsed and appeared as a small round cord. In a case of Mr. Parkin's (*Lancet*, vol. i. 1893, p. 523) the vein was so thickened by periphlebitis as to resemble an empty carotid artery. The part excised showed numerous flaky deposits on the intima. The patient recovered, though there was evidence of advanced pyæmia.

† The bone should be removed so as to give an opportunity of examining the dura mater over the temporo-sphenoidal lobe in the upper part of the wound, and thus dealing with any sub-dural abscess, and the same is true of the bone lying below and posteriorly over the cerebellum. Sir W. Macewen points out the importance of cutting away the bridge of bone between the antrum and the sinus, as this bone “so frequently contains the channels through which the pathogenic organisms reach the sinus.”

and the presence here of even small particles of putrefying clot may determine an extension of the infective clot along the inferior petrosal to the cavernous sinus, just as when a ligature has been left on the upper segment of the jugular it may become a test-tube of pus, and produce a similar disastrous effect" (Ballance). There is no doubt that in some cases, especially of early sinus infection, those where the infection is of small extent, and the thrombus present is one but little broken down, a cure is brought about by obliteration of the sinus alone. But in most cases it is so difficult to come to a safe decision by the aspect of the sinus, the colour and consistence of the clot, the number of the rigors, &c., and thus to tell whether the diseased sinus is firmly occluded on the cardiac side, and whether the thrombus has extended into the bulb, that in all cases of doubt, as well as in those in which well marked symptoms are present, the jugular vein should be operated on as advised above.

The bony outer wall of the lateral sinus having been cut away, and the sinus exposed as far as needful, this is opened with sharp scissors, and all offensive clot within reach cleared out by the sharp spoon and strips of gauze. If, after this is done, blood begins to flow from either end, it is *per se* a favourable sign, as it shows that the clotting does not extend far into the collateral vessels. Brieger, quoted by Mr. Ballance, gives a warning on this point: "The occurrence of hæmorrhage when clearing out the sinus is not *per se*, a proof that the removal of clot is complete. By the removal of such portions of clot as block the entrance of the petrosal sinuses sharp bleeding may occur in spite of the lateral sinus or the jugular being full of clot." There will be no difficulty in dealing with any hæmorrhage from the lateral sinus provided there be room for dealing with it by means of a sufficient opening in the skull. Firm plugging with strips of iodoform gauze wrung out of carbolic acid (1 in 20), and, over this, a dressing of aseptic wool and a knotted bandage, will arrest any hæmorrhage, however free; as occurred in one of my cases, this hæmorrhage may recur freely during the first few dressings, but without any ultimate untoward result. Constant irrigation with mercury-perchloride solution (1 in 4000) should be employed, and iodoform thoroughly used.

In one of Mr. Ballance's cases, though the patient's condition was greatly improved by the operation, the evidence of pyæmia (bloodstained expectoration and swelling of some of the joints) persisted. Ten days after the first operation, as pus could be forced out of the opening in the sinus by pressure on the neck, an incision was made down to the vein at the lower border of the parotid gland. The vessel was opened and pus came out; the sinus and vein were then irrigated with perchloride solution, the stream passing in either direction and bringing away offensive clot. The man recovered.

Sir W. Macewen (*loc. supra cit.*, p. 309) points out that:—"Frequently, in opening the sigmoid groove, granulation tissue protrudes from the dura mater covering the sinus, and often along with this there is oozing of pus. . . . Granulation tissue protruding from the dura mater ought first to be carefully examined with the probe, lest it surround a sinus communicating with the cerebellum and leading into an abscess. If such a sinus exist it requires to be opened and the cerebellar abscess dealt with. If there be no sinus the granulation tissue ought to be removed, as it is apt to harbour infective matter in its sinuosities.

"To obliterate the lumen of the sinus its external walls, which were previously split, are folded inwards. A quantity of iodoform and boracic acid powder, sufficient to fill the interior of the cavity existing between the obliterated sinus and the bone, is introduced, care being taken in doing so not to exert so much pressure as to strip the sinus or surrounding dura from the skull."

EXTRA-DURAL ABSCESS.—This is considered with the following.

MENINGITIS.—This includes two chief forms, viz.: A. Localised pachymeningitis or sub-dural abscess; and, B. Diffuse suppurative lepto-meningitis.

They are thus described by Sir W. Macewen in his masterly account of the various intracranial lesions with which the surgeon may have to deal in otitis media:—

"1. If the inflammatory process be slow, mild, and distinctly localised, involving a portion of the inner table of the skull, then an external pachymeningitis may form, possibly with pus between the dura mater and the bone, producing an extra-dural abscess. And again, when the dura mater has been exposed by osseous erosion, especially common about the tegmen tympani and the sigmoid sinus,* a mass of granulations is thrown out from the outer surface of the membrane. Such a mass is usually surrounded with pus, a portion of which is pent up intracranially, forming an extra-dural abscess, the contents of which ooze out if the neck of the granulation mass, as it issues through the erosion, be gently pressed aside.

"2. Should the above condition (of localised pachymeningitis) persist, adhesive inflammation is apt to spread to the inner side of the dura, which may result in a soldering of the inner membranes, the subjacent arachnoid and even the pia mater becoming adherent by the fibrinous meshes of the plastic exudation. Once this occurs, general lepto-meningitis is guarded against.

"3. After adhesive inflammation has brought about a localised soldering of the soft membranes to the dura, should an increase of the inflammatory action take place sufficient to induce a degenerative inflammation those membranes may soften, in the sub-dural space pus may form, which is prone to be followed by disintegration of the pia and superficial ulceration of the brain tissue. Two conditions may thus result. Should the pia mater remain intact, a sub-dural abscess may form; should the process extend to purulent softening of the pia and adjacent brain-tissue, then cerebral ulceration ensues, the disintegrating products being confined peripherally by the membranes, and by the brain on the inside. In either case the abscess is at first confined to, and enclosed laterally within, the area of the soldered membranes. Should the abscess enlarge considerably, and the disintegrating process affect the adherent membranes now forming the abscess-wall, it is

* And, especially in children, in the neighbourhood of the petroso-squamosal suture (Barker). Dr. Barr, of Glasgow, points out (*Brit. Med. Journ.*, vol. ii. 1898, p. 1234) that extra-dural suppuration in the sigmoid fossa—i.e., on the outer wall of the sinus—may cause severe rigors and high temperature, though no evidence of sigmoid thrombosis exists, and that removing the extra-dural collection (together with any infection in the antrum, &c.) may bring about complete recovery without any need of opening the sinus or ligaturing the internal jugular vein.

possible that the disintegrating inflammation may spread laterally into the sub-dural space, or the abscess may burst into it, thereby setting up an acute lepto-meningitis.

"4. If the cause of the inflammation penetrate through the outer layer of the dura mater into the wide-meshed capillary network of its inner layer before soldering of the membranes has occurred, the whole dural space is open to invasion, and an acute far-reaching lepto-meningitis is apt to ensue."

In the final chapter of his book, Prof. Macewen states that he has had twelve cases of infective purulent lepto-meningitis, of which six were operated on and recovered. The majority were due to septic mischief reaching the membranes through the tegmen tympani; in a few the route was by way of the sigmoid sinus to the membranes in the cerebellar fossa. The lesson Prof. Macewen's success teaches is that the only way to deal with lepto-meningitis is by scrutinising any erosion in the neighbourhood of the tegmen or sigmoid sinus, to expose the inflamed dura freely here with gouge and burr, and, after any extra-dural collection of pus has been dealt with, to freely incise the subjacent inflamed membranes, when purulent intra-dural exudation may escape, generally in drops, and continue to ooze for some time.

OPERATIVE INTERFERENCE IN THE CASE OF FOREIGN BODIES IN THE BRAIN.

Under the above heading such bodies as bullets, knife-points, &c., are included. Depressed and isolated fragments of bone may come within the meaning of foreign bodies, but have already been considered (p. 248).

A. *Bullets.**—The following questions will suggest themselves when a surgeon is called to a case of bullet wound of the skull:

1. *Has the bullet penetrated the skull at all?* Thus it may have lodged, rebounded, or fallen out, or

2. *It may have passed between the bone and the dura mater, without penetrating the latter, and reached a spot quite out of sight.* In such cases Sir T. Longmore advises the use of a curved probe, and extraction of the bullet "with suitable instruments" if it can be felt. Probably in most hands a second application of the trephine, if needful, at some distance from the wound, so as to extract the bullet there, would be preferable to attempts at removing it from the original wound.

3. *Has the ball split into two or more pieces?* Balls elongated as well as round are liable to split when impinging on sharp angles of bone. Thus, when the ball splits upon the outer table, part may pass beneath the scalp, while the rest may drive on before it some of the internal table, causing pressure on the dura mater, or even reach the brain.

4. *Has the bullet penetrated the brain?* If so, where does it lie?

5. Ought any exploration to be performed at once, and, if so, how far is the surgeon to go?

* According to Mr. Barwell (*Clin. Soc. Trans.*, vol. xviii. p. 232) though the weapon may be held very close, there will be neither scorching nor powder tattooing if the bullet be driven by one of the modern fulminates, compared with the projectile.

If the last question be answered in the affirmative, an answer will be given to most of the others.

While, owing to the rarity of gunshot injuries of the head in civil practice in this country, it is very difficult to give a dogmatic answer, the following appears to me to decide in favour of exploring in all cases in which it is clear that the injury is not going to be quickly fatal:

a. The fact that only by exploring will the surgeon be able to answer the question certain to be put to him by the friends, whether the brain is injured or no.

b. Whether the bullet has split, whether the internal table is shattered, and, if so, how far it resembles a punctured* fracture, are points which can alone be cleared up by trephining. See also the remarks p. 327.

c. Disinfection of the wound and good drainage are almost hopeless unless this be opened up and explored by trephining if needful.

The following case is not only a good instance of the kind of gunshot injury to the head which may be met with in civil practice, but it shows how slight may be the injury which actually originates the fatal mischief. It was brought before the Clinical Society (*Trans.*, vol. xii. p. 5) by Mr. Lucas.

The patient, aged 21, had shot himself with a small revolver. "Almost in the centre of his forehead were two small circular holes, with slightly inverted edges. The surrounding skin was raised into a rounded eminence. There was some bleeding from the nose as well as from the wounds. On turning back flaps, a blackened cavity was opened beneath the skin, formed by the expansion of the powder after it had penetrated the integument. At the bottom of this cavity, a somewhat cruciform aperture was seen in the bone, and lying upon the internal table were two flattened bullets. The internal table was driven back so as to give the appearance of a sinus, in which the bullets were lying loose; and at the time we were under the impression that the man had very large frontal sinuses, which had been opened by the bullets. After removing numerous fragments belonging to the external table and diploë, the splintered internal table forming the posterior wall of the cavity was also removed. This came away in large, sharp-edged, angular fragments, two of which were grooved by the longitudinal sinus. When the internal table had been removed, the dura mater was seen at the bottom of the wound, and pulsating. The membrane was entire except at one spot, where there was a small aperture just such as might be made by stabbing the point of a penknife into a sheet of paper. But for that small puncture, it is not improbable that he would have recovered." Infective meningitis came on in about forty-eight hours, followed by death early on the sixth day.

I will suppose that a surgeon decides to explore a gunshot injury of the skull. He does so with the intention of rendering the wound as sterile as possible,† removing all dirt, hair, and splinters in the cortex, if accessible, without making the condition of the patient worse than it already is. He will have warned the friends that removal of the

* Excellent instances of how closely some gunshot fractures may resemble the classical "punctured" fractures, not only in the greater damage to the internal table co-existing with but slight mischief externally, but also in the onset of grave symptoms inevitably fatal unless trephining be performed early, are shown in Figs. 79 to 88, *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. pp. 168, 169.

† It is not the bullet so much as the fragments of bone driven in which will cause infection. This is borne out by the military experience in South Africa. Here also, while suppuration was rare after bullet injuries, it was the rule in wounds due to fragments of shell.

bullet may be found impracticable on this occasion owing to the patient's condition. We will suppose that no cerebral symptoms are present, either focal ones to guide him, or such grave ones as coma, stertor, paralysis of the sphincters, which would lead him to stay his hand. Lastly, the injury is not of that destructive character, so shattering the skull and ploughing up the brain, especially in a direction towards the basal ganglia, as is certain to prove quickly fatal.

Treatment.—While the head is being shaved and preparations for an operation made, the surgeon will take note of any superficial lesions, such as marks of smoke or flame, grains of powder, and the original characters of the external wound, both for medico-legal purposes and for future guidance, all these lesions being soon liable to alteration. It is rare, supposing the patient to have recovered consciousness, that any localising symptoms are present, which can point to the lodgment of the bullet in a definite part of the cortex, *e.g.*, the motor, or the visual and speech area.* In a few cases, as soon as the whole head is shaved, the surgeon may gain evidence of the position of the bullet by finding on the opposite side of the skull a contusion of the scalp, an elevation of the bone, or only a tender spot, beneath which, after incision, some fine fissures may be detected (Phelps). The surgeon, having raised an appropriate flap, enlarges the skull wound with Hoffmann's forceps and removes any dirt, soft parts which will certainly die, and superficially lying splinters. He next explores the track of the bullet. As with the usual fine metal probes it is very easy to lose the track, make false passages, and thus inflict fresh damage, as well as add to the embarrassment and difficulty of the case, it will be wiser to make use of a sterilised straight bougie.† In the case of a small bullet, the opening in the dura mater will need searching for in a good light. "It has been held that when the probe ceases to advance without the exercise of force, the limit of persistence has been reached. This is approximately rather than exactly true. The probe does not fall by its own weight into the depths of the cerebral wound. The channel which the bullet has left behind it is not likely to be open, but filled with coagula and disintegrated tissue, and some force, gentle as it may be, is required to penetrate this pulpy mass, and some manipulation alone can guide the instrument past obstructing osseous fragments or through an intra-cerebral dural opening" (Phelps). In those cases where, owing to the shortness of range, or the large size

* Any such lesions, which may rarely be noted immediately, are due to the passage of the bullet; if occurring later on they will mark certain secondary morbid conditions. Of the infrequency of the aid which cerebral localisation gives, Dr. Phelps, of New York, thus wrote (*Traumatic Injuries of the Brain and its Membranes*, p. 343): "The extent of cortical area, which, as yet, must be regarded as latent or of indeterminate function, is so great, and the further probability that the bullet will rest in some subcortical region is so strong, that such aid is scarcely to be expected." The above work is the outcome of large personal experience, and I here acknowledge my indebtedness to it.

† If, as is likely, the probe chosen is Nélaton's, the surgeon will remember two fallacies which may accompany its use: one, that the porcelain bulb may rub off a stain of lead from any structure on which the bullet has impinged, without actual contact with the latter; the other and more likely fallacy is, that the bullet may be so covered by blood or shreds of soft parts, or the porcelain so smeared with blood, that the characteristic stain may be wanting, though the bullet has been reached.

of the bullet, the size of the wound in the skull and the destruction of tissue along the track of the bullet admit of it, a sterile finger will replace any other means of exploring. Fragments of bone or bullet accessible within the cortex after due enlargement of the wound are removed with dressing-forceps or small scoop. The same will effect the removal of the bullet if found. Clots should, if possible, be removed by irrigation. Dr. Phelps gives the following as indications for the use of a needle when the bullet cannot be detected by a probe: "A resistance may be felt which the blunt instrument fails directly to reach; there may be reason to believe that the missile lies near the cerebral surface, while an angle in its track prevents direct pursuit without incision; a deeper wound may be too tortuous to follow; or localising symptoms may have developed."

If the surgeon fail to find the bullet he will, in the majority of cases, do well to wait for an improved condition of his patient and a trial of the Röntgen rays. If he succeed in finding it he must consider whether the state of the patient justifies further interference. While profound unconsciousness and deepening coma or a marked condition of shock forbid any further interference, it will be better, if the site of the bullet can be traced with anything like certainty, to remove it at once, and so minimise as much as possible the risks of infection. The question whether the bullet is to be reached directly or by counter-trephining now arises and must be decided by the depth at which the missile lies according to the evidence given by instruments or the finger.

Dr. Phelps thus advises on the justification of counter-trephining:—"The circumstances adverse to this step are—first, a bad general condition of the patient succeeding primary shock, a high temperature, a feeble and frequent pulse, and other indications of an inability to sustain the shock of further cerebral injury; second, extensive cerebral laceration about the wound of entrance, from the explosive effects of a large bullet at close range, or a suggestion of wide destruction in its track, from the severity and diversity of localising symptoms; third, great uncertainty as to the course of the ball, or its direction towards an inaccessible cranial area; fourth, the fact that its course has involved the base of the brain; and fifth, the bullet having been of 0·22 cal. or less. The fact that the bullet has taken its course upon or near the basilar surface is to be regarded as a contraindication, because it is more than likely to be deflected near the median line into a central region of the brain by resistance offered by some part of the ethmoid or sphenoid, or by the basilar process. The fact that the bullet is of 0·22 cal. or less is a contraindication, because its course is usually erratic and its track minute, and because its momentum is so comparatively slight that it rarely reaches an accessible part of the opposite cerebrum. No one of these contraindications, of course, is an absolute bar to operation. If, on the contrary, the constitutional condition is good and the laceration confined to a narrow track, if a bullet of 0·32 cal. or larger has been driven through the central or upper region of the brain towards some part of the vault, if its track can be traced deep into the opposite hemisphere,*

* On the question of the probability of bullets in the brain following a direct track Dr. Phelps writes as follows:—"If the wound can be traced directly inwards for an inch

and more especially if the patient have the advantage of youth, it will be judicious, after the exhaustion of other means, to resort to this ultimate mode of relief."

Before inflicting this additional injury, and running the risk of causing, perhaps, further severe loss of blood from incisions in scalp, dura mater, and brain, the surgeon will take into careful consideration the condition and vitality of his patient. Too much weight must not be attached to Dr. Fluhner's successful case given below. Very few patients will stand an operation of four hours' duration, and it is obvious that other complications might arise which would prolong the operation, if once undertaken.

On account of its importance I will again refer to the question of disinfection and drainage. In order to thoroughly cleanse of any powder, dirt, or lead splashes the external wound in the skull, even after this has been enlarged with Hoffman's or other forceps (p. 363), it may be needful to resort to rubbing with sterilised gauze or even the use of the gouge. The incision in the dura should be sufficiently enlarged to give exit to any blood or cerebral debris. If uninjured or very slightly injured, the bullet having been deflected, the dura should be most carefully examined before it is taken for granted that the parts beneath have not been implicated. If this membrane, though uninjured, is bulging it is always to be opened. Any splinters of bone which have been carried along the track of the bullet are to be carefully removed. If irrigation of the bullet-track is practised, so as to get away infected clots or sloughs, it will be well to plug round the opening in the skull with strips of iodoform gauze lest the fluid carry infected particles into the arachnoid or sub-arachnoid spaces. Dr. Phelps is of opinion that drainage-tubes are to be employed with much reserve, and only in cases where there is great and widespread damage to the central regions of the brain. If used at all, drainage-tubes should be withdrawn and abandoned at a very early period, usually on the second day. If drainage is to be maintained for a longer time, horsehair or threads of chromicised gut may replace the

or more, while it is still possible that an elusive pistol-ball may have been deflected by a dural reflection, or have stopped short from exhausted force at any point just out of reach, it is more probable that it has gone straight onward at least as far as the opposite dural wall, and that further search must involve a new departure. It has been assumed that the bullet in its passage through the brain is likely to be diverted from its direct course by trivial obstacles, as is known to be the case in the extremities or in certain regions of the trunk. This complication is, in fact, less to be expected within the cranial cavity than elsewhere. The density of the brain substance is very much the same from one surface to the other, and it has been found in both ante-mortem and cadaveric wounds that the reflections of the dura mater are usually penetrated without the direction of the bullet having been changed. It is, nevertheless, the fact that in a considerable proportion of cases the bullet which fails of exit is turned aside from its direct course. The change impressed upon its direction is due not to deep intracranial obstruction, but to the resistance offered by the cranial wall and dura mater at its entrance, or by the same structures upon which it may impinge at a point upon the opposite side of the head. A bullet, especially if of small size, with or without penetration of the dura mater, is often at once deflected at a right angle, or, if of larger size, after traversing the brain, and having insufficient force to penetrate the opposite dural wall, falls back into the track and is diverted, perhaps to a considerable distance, in some new direction."

tube, and their number be reduced from day to day. The following objections to the employment of drainage-tubes must be remembered: (1) that they are irritant foreign bodies; (2) that they are likely to become filled with clot, and thus act as plugs rather than as drains; (3) that they are media for the deep implantation of infective elements when the surface is no longer sterile.

The following is an interesting instance of successful operation for the removal, by counter-trephining, of a bullet penetrating the brain:

The patient,* aged 19, shot himself with a pistol held very near to the centre of his forehead. About twelve hours afterwards, when seen by the surgeon, he was semi-conscious, aphasic, with complete loss of motion, without loss of sensation on the right side below the head. Left side hyperæsthetic. Pupils equally dilated. P. 100, T. 101.4°.

FIG. 122.



a, b, Track of bullet and site of the trephine-openings. *c*, Spot where the bullet was found. (Fluhrer.)

Ether was given, and, under the protection of copious irrigations of corrosive sublimate solution (1 in 1000), the wound of entrance, nearly in the centre of the forehead, was enlarged, including also the wound in the skull. This procedure was complicated by most profuse hæmorrhage from a branch of the anterior cerebral artery, which was finally controlled by small compression-forceps left *in situ*. To this arterial bleeding was added a considerable venous flow from the superior longitudinal sinus, which, like the artery, had been cut across by the bullet. The track of the ball through the brain was then examined by a straight Nélaton's probe,† and the point on the scalp noted

* This case was under the care of Dr. Fluhrer (*New York Med. Journ.*, March 28, 1885).

† Dr. Fluhrer considers that a probe for these cases should supply the following conditions. The end should be large, so as not to wound the brain and make a false passage, and also, when beneath the surface, be easily discoverable by palpation or dissection. It must be sufficiently rigid to retain a given shape, and sufficiently bulky to supply a large surface to the fingers. Finally, it should be as light as possible, that delicacy of touch be not lessened, and that no vibrations be lost instead of being communicated to the fingers. It should be made of tempered aluminium. If it be necessary to curve it near the exploring end (which increases the errors in interpreting the position of the extremity), the other end of the shaft should be bent, in the same plane, in the opposite direction.

at which the probe would emerge if projected through the head. At this point the cranium was exposed and trephined. The trephine-hole was enlarged towards the assumed opening of emergence of the bullet, and the dura mater slit in the same direction. Some effused blood and disintegrated brain tissue appearing, more of the skull was cut away, and the slit in the dura mater prolonged until a gush of brain tissue and a rent in the pia mater demonstrated the point of impact of the bullet. The probe was introduced through the opening in the pia, and passed downwards towards a point where a feeling of resistance had previously been noted with the tip of a finger introduced through the second opening. At the distance of an inch the bullet was detected, and then extracted with slender-bladed forceps; it weighed 42 grains. One end of a small rubber drainage-tube was secured to one end of the probe; this was again passed through the brain from before backwards. The tube, as it was drawn through the wound, became filled with brain-detritus and blood. The after-history was one of gradual but progressive amendment. On the sixth day the drainage-tube was withdrawn, and replaced by a drain made of four strands of catgut and ten of horsehair, this being passed by tying it on to the anterior end of the drainage-tube. As the tube was withdrawn the drain occupied its place. It was removed, strand by strand, on different days. On the eighth day the compression-forceps was found to be loose. A hernia cerebri developed at both cranial openings. The hernia being subjected to a slight continuous pressure gradually disappeared. Eleven weeks after the operation, both wounds had healed. The operation was completed in about four hours, the greater part of the time having been spent in stopping the cerebral hæmorrhage. After leaving the hospital the patient returned to work, a slight impairment of memory being the only apparent consequence of his wound. A severe blow accidentally made upon the anterior scar, some months after returning to work, determined a violent convulsive attack, which recurred at the end of three weeks. Bromides were freely given, and no further recurrence had taken place when the report was made six months later.

The case will amply repay careful perusal. It is a splendid instance of what surgical skill can effect.

I will next take a case where, by careful exploration, the patient has been saved from the numerous risks of infection, but the bullet has not been found. The wound has healed, and the question arises as to whether the bullet should be removed or allowed to remain. Where headache or any local symptoms are present, we will say two to three months after the injury, the course to follow is clear, especially if the Röntgen rays clearly localise the bullet. But it is not so easy to give an answer in those cases where, after healing of the wound, cerebral symptoms are absent, or extremely slight, and, perhaps, the Röntgen rays are unable to define the position of the bullet. On the one hand, any honest surgeon knows that by operating he may, in spite of all his care, expose his patient to dangers greater, perhaps, than those entailed by leaving the bullet alone. On the other hand, the evidence is strong that if a large number of cases of recovery without removal of the bullet were accurately watched for long periods, many would be found to be cases of incomplete recovery. Thus, Dr. Otis* writes of balls lodged within the cranial cavity.

"Many instances were reported of patients who had survived the lodgment of missiles within the skull, but few or none resembling the cases reported by Larrey, of balls encysted in the brain and giving no inconvenience for years. It is, indeed, reported that some patients went to duty with balls lodged in the cerebrum; but the diagnostic details accompanying the history of these cases are not sufficiently precise to invite the fullest confidence. In most of the cases in which the evidence that the ball remained

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. p. 193.

within the skull was conclusive, either fistulous sinuses existed, or there was much cerebral disorder,* or the position of the missile was discovered after the patient's death at a period remote from the injury."

The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later, even as long as fifteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain tissue, or yellow softening is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes. The usual termination is cerebral abscess, this condition having been found in fifty-three cases in which a necropsy was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain symptoms, is that quoted by Wharton from Flourens. This observer found that bullets introduced into different portions of the upper parts of the hemispheres and the cerebellum gradually penetrated the brain substance, ultimately reaching the basis cranii, the bullet-tracks healing after them (Nancrede, from Wharton). "There is probably no authenticated case, of recent Anglo-American record, in which a bullet left in the brain substance has failed to work mischief, nor has the mischief been often long procrastinated. There have been occasional instances in which it has remained harmless for a number of years in the cranial cavity, but the brain has not been penetrated. The fact that epilepsy has developed so late as fifteen years after injury must make even apparently exceptional cases doubtful" (Phelps).

In doubtful cases such as those I have mentioned above, it appears to me that the surgeon should put both sides of the question before the patient or the friends, and leave the decision to them.

Where an operation is decided upon, Dr. Fluhner's case given above, and the following detailed case by Mr. W. Sheen, of Cardiff (*Lancet*, vol. ii. 1904, p. 825), will be found extremely instructive. Mr. Sheen's case is quite one of the most helpful records of such injuries in modern times:

The man, æt. 23, had been struck by a revolver bullet about two cm. to the left of the mid-frontal line, and the same distance above the supra-orbital arch. Owing to the depth of the bullet, about twelve cm. from the point of entrance, it was not considered advisable to extract it at first. Ten weeks later there were still attacks of left parietal and frontal headache, some motor aphasia, and weakness in the right leg. The position had been localised with the Röntgen rays by Dr. Martin, whose remarks are given below,

* Prof. Nancrede (*Intern. Encycl. of Surg.*, vol. v. p. 72) gives the following important abstract of a most careful paper by Dr. Wharton (*Phil. Med. Times*, 1879) in which 316 cases of foreign bodies lodged in the brain are analysed. Of these, 160 recovered, while 156 proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in 106 cases, 72 recovering, while only 34 died. In the remaining 210 no attempt at removal was made, and only 88 recovered, 122 dying. A further analysis shows that, amongst those cases classed as recoveries, death ultimately took place in 10 at periods varying from three to ten years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deteriorated mental powers.

at a depth of 6.5 cm. from the lateral surface of the head. A flap was turned down behind the left ear, and a 1-inch disc removed above and behind the meatus. This opening was enlarged downwards and forwards, the dura mater opened, and the bullet searched for "by entering a probe 3.5 cm. above the meatus, and 2.5 cm. behind the intermeatal line and passing it in the horizontal plane of the head for a depth of 6.7 cm. The bullet not being felt, Hedley's telephone-probe was passed in the same line, and after feeling a moment, a rather doubtful tap was felt. The probe was withdrawn, and a pair of ordinary dressing-forceps passed in felt the bullet, which bobbed about in an elusive way, suggesting the possibility of its being in a cavity." At a second attempt the bullet was removed, with a little brain substance adhering. The length of forceps introduced measured 6.5 cm. from the skull surface. As there was considerable increase of intracranial tension some of the brain substance had to be removed before the dura mater could be brought together. The disc of bone was replaced and the wound closed with drainage. The after progress was uneventful. There was no paralysis or aphasia. The tube was removed the day after the operation; by the eighth day the wound was healed, and in three weeks the patient got up. There was some weakness still of the right arm and leg, and dimness of vision in the right eye. About five months after the operation the patient resumed his work as a stoker, and is believed to have continued it since.

Such cases as the above are the ones likely to be met with in civil practice. In a case like this revolver bullets, with comparatively low velocity, inflict damage largely limited to their track. On the other hand, as pointed out by Mr. Makins (*loc. supra cit.*, p. 248), a high velocity bullet of the modern small-arm type not only fissures the skull extensively, but, as it rushes into the brain, scatters waves of destruction in different directions. The exact course of the bullet, as in Mr. Sheen's case, above the ventricles and basal ganglia, helps also to determine the result. With regard to the justifiability of the operation, all will agree with Mr. Sheen's remarks: "The man was nearly free from symptoms, and apparently on the road to complete recovery. There were, however, certain symptoms, viz., intermittent headache, pain on moving the head, and at least one definite severe attack of headache, with temporary remission of symptoms. Then one realises that the heavy bullet may change its position; its being felt as if in a cavity, at the second operation, supports this possibility." Mr. Sheen then alludes to the after-dangers I have given at p. 323: "The disturbing influence on the patient of the fact that a bullet is in his brain has also to be taken into account; in this case the man was very desirous to have the bullet removed. Finally, one might point out that an operation conducted aseptically and carefully, even if the bullet were not discovered, would not be likely to do any harm."

Surgeons facing similar cases will bear in mind Mr. Sheen's remarks on instruments required in these cases. Practically the extracting forceps found the bullet. In order to obviate as far as possible the re-introduction of instruments—it is noted that at the second operation, where there was no bullet-track, the introduction of one instrument did not leave a passage for the next—a bullet-probe forceps is desirable, *i.e.*, an instrument which can be attached to the telephone-receiver and which both detects and extracts the bullet. Such an instrument should be graduated, so that it can be at once noted when it has entered the required depth.

The remarks of Dr. W. Martin on the result of the Röntgen rays are of equal interest: "When the question of removing the bullet was brought forward, skiagrams were taken laterally and antero-posteriorly,

and localisation was performed by the double impression on the single plate, and the Mackenzie-Davidson cross-thread localiser. By these means it was found that the depth of the bullet from the plate was 6.9 cm. About 5 cm. were allowed for scalp, &c., intervening between the plate and the external surface, so that it was calculated that the centre of the bullet, approached on the horizontal plane of the head from a point 3.5 cm. above the left meatus, and 2.5 cm. behind the intermeatal line, would be found at a depth of 6.4 cm. This distance was checked by the antero-posterior view, which placed the centre of the bullet between 6.4 and 6.5 cm. The night before the operation, in order to make certain that no serious alteration in the position of the bullet had taken place since the localisation, stereoscopic impressions were made, and from the wet plates prints being obtained by artificial light, the surgeon was enabled to see the bullet *in situ* before beginning the operation. . . . Stereoscopic views of foreign bodies lying deep in the cranial cavity do not, however, give a very clear idea of the exact depth, owing to the absence of intervening landmarks, in the same way that distances at sea are so difficult to estimate. The uniformity of the surfaces of the parietal bones accentuates the difficulty in cases such as this one."

Röntgen Rays.—This method has proved itself highly useful of late in the localisation of bullets within the skull. The method used by Dr. W. Martin, of Cardiff, who gave such valuable assistance in Mr. Sheen's case, is given above. For the following I am indebted to Mr. Edward W. H. Shenton, who is in charge of the Röntgen ray department at Guy's Hospital:—

"It is possible by means of the Röntgen rays to estimate the size of, and to exactly locate, bullets or other bodies which have become lodged in the cranial cavity. With a Crookes' tube of sufficient penetrative power—preferably the kind that gives the bone-image upon the screen as a soft grey shadow—the bullet may be seen *in situ* in the lateral position, and, under favourable circumstances, even in an antero-posterior. When a head is viewed in this latter direction, so much dense tissue has to be penetrated by the rays that it is a rare occurrence for a bullet to be shown upon the fluorescent screen. In determining the exact position of a foreign body in the head, it is obvious that greater accuracy is needed than in most other situations of the body. Many methods have been devised for the purpose of obtaining this exact localisation. The simplest method, perhaps, is that where two skiagrams are taken—one in an antero-posterior direction, the other in the lateral. These two pictures will, if taken with due care that the directions are as nearly as possible at right angles to one another, prove of assistance to the surgeon in an operation for the removal of the foreign body. A few details of the process for obtaining these two views will not be out of place here. The patient is placed on his back on a table with a canvas top, and the tube is arranged beneath his head and beneath the table. He should lie squarely upon his back, his head being steadied with sand-bags. The room being darkened and the tube illuminated, the screen is placed upon the patient's forehead. The tube is now moved about until the image of the head presents symmetrical outlines. A photographic plate is substituted for the screen, and the requisite exposure

given. For the second skiagram a similar process is performed with the head in a lateral position, the patient's profile being the guide as to the accuracy of the directly side-to-side view. This method, though satisfactory as a rough guide, is far from perfect, there being so many directions in which error may be made. Another system, and a far more accurate one, is that now in common use at Guy's Hospital. It is a system whereby the exact distance from any given point may be found, and the principle upon which it is based is as follows:—When an image is being viewed upon the screen and the tube moved, the shadows of the various parts of the object viewed will move upon the screen at different rates according to their distances from the screen; that is, the nearer to the screen the less distance their shadows will travel in a given time. Quite superficial objects, those almost touching the screen, will hardly move at all. By a suitable arrangement of mechanism exact measurements are easily obtained, and, in all cases where the foreign body can be seen upon the screen, this can be accomplished without the involvement of any photographic process. If considered desirable in the case of bullets in the head, a skull may be taken and a bullet arranged in it, by the aid of the measurements obtained, to correspond in situation to the original bullet. Such a device will prove of great value to the surgeon at an operation for the removal of the foreign body. When exact localisation has been obtained, radiography can go no further, unless the practice of operating with the rays to hand is adopted. By such a method the surgeon is enabled to see the position of the foreign body from time to time, and any metal instrument he may be using. Until tubes of greater power are forthcoming this method cannot be advised for cases of bullet in the head."

A paper by Braatz* (*Centr. f. Chir.*, Hft. i. 1898) on the successful extraction of a bullet from the brain, with the help of the Röntgen rays, is of much practical interest. It will be seen that in this case a first attempt was unsuccessful, and that a needle was of much use in detecting the actual site of the bullet.

A lad, æt. 16, was in November, 1895, shot in the right temple by a revolver-bullet of small size. The immediate symptoms passed away in a few days, but, after an interval of good health lasting for six months, intense headache was complained of in the left side. The Röntgen rays—a plate having been placed beyond the left side of the head—showed the foreign body lying in front of the left ear, and on the level of the zygoma. A little higher was another shadow which was thought to show that spot on the inner wall from which the bullet had rebounded. Braatz made an unsuccessful attempt to remove the bullet, the operation being hurried owing to the failure in respiration under the anæsthetic. After waiting for two weeks the headache returned as intensely as before. On Nov. 17th, 1897, the position of the bullet having been again defined by the Röntgen rays, the old wound in the skull and dura mater was opened up, and when the surface of the brain was exposed, a small hard body could be felt on exploring with a blunted needle. The brain tissue having been divided along the track of the needle, the bullet was easily extracted. A rapid recovery followed.

Anyone seeking further information on the use of the Röntgen rays in bullet wounds of the skull should refer to a paper by Prof. Keen and

* The following paper, and the references which it contains, may be found useful. "Localisation of Foreign Bodies by the X-rays," by Dr. W. R. Fox (*Lancet*, Sept. 21, 1901, p. 785).

Dr. Sweet (*Amer. Journ. Med. Sci.*, July, 1903). A full description is given of Dr. Sweet's method of localisation, with figures of his apparatus.

The rays demonstrated here eight fragments of the bullet, one principal one, and seven others of minute size. The position of the chief fragment was localised horizontally at a depth of 6.3 cm. The paralysis of the left lower limb which had been present was steadily diminishing. The severe epileptic attacks which had set in shortly after the injury had not recurred. It was probable that the injury necessarily inflicted by any operation would be greater than that which the bullet was causing. For these reasons Prof. Keen decided against operation. To decide whether any change in the position of the chief fragments took place in the future, Prof. Keen removed two small round portions of the scalp with the hair-follicles under cocaine, in order to leave two permanent bald patches over the spot where the chief fragment had been localised.

Treatment of Gunshot Wounds of the Head, of the modern small-arm type.—The following remarks by G. H. Makins, C.B. (*Surgical Experiences in South Africa*, 1899—1900, p. 293) are of twofold interest, first from their recent date and their bearing on the effect of modern small projectiles of high velocity, and, secondly, from the wide practical experience and weight with which the writer speaks.

"Operative interference is necessary in every case in which recovery is judged possible. The injuries are, without exception, of the nature of punctured wounds of the skull, and the ordinary rule of surgery should under no circumstance be deviated from. An expectant attitude, although it often appears immediately satisfactory, exposes the patient to future risks which are incalculable. . . . Cases of a general character,* or in which the base has been directly fractured other than in the frontal region, are seldom suitable for operation, since surgical skill is in these of no avail; but in all others an exploration is indicated. I use the word 'exploration' advisedly, since what may be called the formal operation of trephining is seldom necessary except in the case of the small openings due to wounds received from a very long range of fire; in all others there is no difficulty but very great advantage in making such enlargement of the bone opening as is necessary with Hoffman's forceps.

"The scalp should be first shaved and cleansed; if for any reason an operation is impossible, this procedure at least should be carried out, with a view to ensuring, as far as possible, future asepsis, infection in head injuries being almost the only danger to be feared. The scalp having been cleansed with all care, a flap is raised, of which the bullet opening forms the central point, and the wound explored. In slight cases the entry wound is the one of chief importance, and the exit may be simply cleansed and dressed. The flap having been raised, if the wound be a small perforation, a $\frac{1}{2}$ -inch trephine crown may be taken from one side; but it is rare for the opening to be so small that the tip of a pair of Hoffman's forceps cannot be inserted. The trephine is more often useful in cases of non-penetrating gutter fractures where space is needed for exploration, and the elevation or removal of fragments of the inner table. Loose fragments may have to be removed from beneath the scalp, but the important ones are those within the cranium. These may either be of some size, or fine comminuted splinters of either table, often at as great a distance as two inches or more from the surface. The cavity must be thoroughly explored

* Under this heading are included extensive sagittal tracks passing deeply through the brain, and vertical wounds passing from base to vertex or *vice versa*, in the posterior two-thirds of the skull. For their production the retention of a considerable degree of velocity on the part of the bullet was always necessary, and the results were consequently both extensive and severe. Civil practice supplies instances of the first group, especially in the form of revolver-bullet injuries occasionally met with in this country.

and all splinters removed. I have seen more than fifty extracted in one case of open gutter fracture. The brain pulp and clot should then be gently removed or washed away, and the wound closed without drainage. Fragments of bone, as a rule, are better not replaced, but complete suture of the skin-flap is always advisable in view of the great importance of primary union, and the fact that a drainage opening exists at the original wound of entry, and that the wound is readily reopened to its whole extent, should such a step be advisable.

"The detection of fragments is easiest and most satisfactorily done with the finger, and in all but simple punctures the opening should be large enough to allow thoroughly effective digital exploration. The determination of the amount of brain pulp which should be removed is somewhat more difficult; all that washes away readily should be removed, and its place is usually taken up by blood.

"Few fractures of the base are suitable for treatment; the only ones I saw were those of direct fracture of the roof of the orbit or nose, produced by bullets passing across the orbits. Here the advisability of interference with the injured eye led to opening of the orbit, and sometimes exposed the fracture.

"As to the most satisfactory time for the performance of these operations . . . in head injuries the advantages of early interference were more evident than in any other region. This depended on the fact that, as in civil practice, the scalp is one of the most dangerous regions as far as the auto-infection of the wound is concerned, and one of the most difficult to cleanse, except by thorough shaving." *

With regard to the treatment of retained bullets, which are stated to have been distinctly rare, Mr. Makins advises that the operation should not be undertaken until "the patient can be placed under the best conditions which can be secured. . . . Such operations need the infliction of an additional wound, require great delicacy, and may be very prolonged in performance." Earlier interference is only indicated where the bullet has tried to escape, or secondary symptoms develop pointing to irritation.

B. Other foreign bodies besides bullets which may penetrate the brain are *knife-points*. These, with their tendency to form cerebral abscess, have already been alluded to (p. 250).

C. Another class of body which may be met with by the surgeon in civil practice is shown in the following case of Mr. Couper's: *

A house painter fell twelve feet from a ladder, impaling the right side of his skull on the spike of an iron palisade. When brought into the hospital there was a clean-cut wound three-quarters of an inch long, immediately under the right ear, partly overlapped by its lobule. In this the end of a large rough piece of metal, corresponding to a freshly broken spike, could be felt, and its direction could be inferred to be upwards, inwards, and a little forwards from the outer wound, which was situated half an inch under the external meatus between the mastoid process and the ramus of the jaw. There was some bleeding from the right ear, but no facial or other paralysis. The patient being under chloroform, Mr. Couper succeeded, after much forcible wrenching, in extracting the iron, the head being as far as possible steadied by three students and the operator's hand. During these efforts three or four ounces of blood oozed from the wound; this hæmorrhage ceased as soon as the iron was out, but a small quantity of semi-fluid brain substance flowed. Right facial paralysis came on two days after the injury, then delirium, restlessness, and on the seventh day left hemiplegia, followed by convulsive attacks affecting the right limbs and right half of the face. Two days later, or nine days after the accident, the patient died.

Necropsy.—No pus between the dura mater and the bone; dura mater healthy, save for congestion. On opening it, the surface of the right hemisphere showed well-marked sub-arachnoid meningitis. The posterior part of the right middle cerebral lobe had been deeply wounded: the brain substance, at this spot softened and streaked with pus, was

* *Lond. Hosp. Reports*, vol. ii; *Hutchinson's Clin. Surg.*, vol. i. p. 91, pl. xvii.

healthy everywhere else. The spike had entered just under the apex of the mastoid process, traversed the internal ear, and driven several irregular masses of petrous bone through the dura mater.

In a similar case, the careful use of chisel or gouge would loosen the foreign body, while the opening up of the wound would facilitate drainage and cleansing the parts damaged, including the brain itself and its membranes.

OPERATIONS ON THE FRONTAL SINUSES.

Chief Points in the Surgical Anatomy.—These are of primary importance as it is never to be forgotten that while operative interference with the maxillary antrum is a very safe proceeding, a similar step in the case of the frontal is a very different matter; owing to the close proximity of the cerebral meninges and the communication of these sinuses with the ethmoid and nose, the risk of fatal infection, especially osteitis and meningitis, is now always present. *Extent.*—The degree to which the limits of these sinuses vary outwards, upwards, and backwards is well known. The last mentioned, or the depth, is the most important from the surgeon's point of view. Logan Turner gives the following as averages. Height, $1\frac{1}{4}$ inches; breadth, 1 inch; depth, $\frac{3}{4}$ inch. When the sinuses are asymmetrical, one may extend across the middle line, reducing its fellow to a mere slit. The septum, complete in health, is often perforated in disease of any standing. Thus, where both sinuses are diseased and communicating, discharge may appear in the nose on one side only (Tilley). While the posterior wall, thin and brittle and marked posteriorly by the frontal convolutions, contains no diploë, in the anterior wall this tissue, though slight in amount, is sufficiently present to be the seat of infective osteitis. The floor of the sinuses at its inner and posterior part is formed by the anterior ethmoidal cells. The bone here is delicate, readily giving way. From this fact and the close contiguity of the openings of other sinuses, *i.e.*, the anterior ethmoidal and the antral to that of the frontal in the middle meatus, infection readily spreads from one to the other. The upper opening of the *naso-frontal duct* lies at the back and inner part of the inferior wall of the sinus. It is on this part of the sinus, *i.e.*, that just above the internal angular process, that the surgeon should especially keep his attention. The duct passes through the anterior ethmoidal cells. Its direction is downwards and backwards. Slightly curved backwards, it may be tortuous; sometimes a mere slit represents the upper opening. Apart from the results of disease, difficulties may arise in the passage of a probe along the duct owing to the way in which it may be encroached upon by the anterior ethmoidal cells, and its varying length according as it opens directly into the upper part of the middle meatus, or farther down, in the groove known as the hiatus semilunaris, in common with the openings of the anterior ethmoidal cells and the antrum. The latter is the more common of the two, and may account for the frequency with which the antrum is also involved. The site of the opening into the middle meatus is denoted on the surface by the level of the internal canthus (Godlee).

Chief Indications for Operation.—These will be chiefly pain, evidence of retained infective material and altered health, bodily and mental, in chronic cases, from the constant swallowing and breathing of such material, and the resulting toxæmia. I shall presume that intra-nasal treatment is not available, or that it has failed. With regard to pain there is a wide difference between acute and chronic cases. In the former, it may be agonising; in the latter, as long as the fronto-nasal duct is patent, it is much less prominent, Dr. R. Milligan (*loc. infr. cit.*) goes so far as to say of these cases: "Localised pain, which is such a valuable symptom in the diagnosis of deep-seated suppuration, is usually conspicuous by its absence. It is true that pressure over the floor of the sinus, which happens to be its thinnest wall, does at times produce marked pain, but an almost equal amount of discomfort is not uncommon when similar pressure is made over the floor of the opposite sinus. The finger must be introduced well under the supra-orbital arch, and pressure made upwards and inwards." Where the surgeon is in doubt as to the need of an operation, the chief point for him to weigh is whether adequate drainage exists. Where the fronto-nasal duct remains patent, and patients defer operation, they must clearly understand the need of attending regularly to report their condition and to allow of the removal of the polypi or granulation-masses which arise here, as elsewhere in the course of long-continued suppuration. In such cases, the patients must be warned of the risks of fresh attacks, *e.g.*, of influenza, in interfering with the escape of discharge, and of resulting cerebral complications, as in the more familiar instance of imperfect drainage through an ulcerated membrana tympani in otitis media. Operation is strongly indicated where the discharge is profuse, where the sinus is distended without escape of discharge by the nose, and, especially, where there has been any threatening of cerebral trouble, and where the antrum is involved as well. Another point that should have weight is that the longer operation is deferred the more prolonged will be the after-treatment, and the greater the risk of deformity. Two other indications to be added to the above are the presence of a discharging sinus, and the possibility that the patient may be remote from surgical assistance (Tilley).

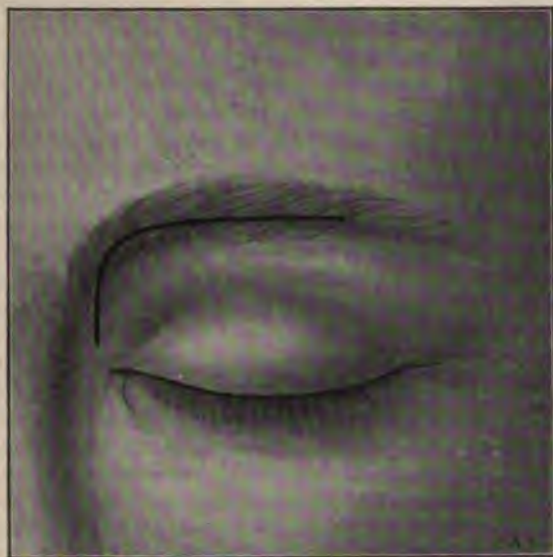
If the question of **prognosis after operation** be raised, most authorities speak most decidedly as to the completeness of the cure. Dr. Milligan (*loc. infr. cit.*) takes a less sanguine view with regard to the entire disappearance of pus. And he is speaking from an experience of forty cases. While this authority considers "a very guarded prognosis always advisable, after opening and draining the sinus headache disappears, and the state of the general health becomes much improved."

Operation (Figs. 123 and 124).—This will vary according as the case is acute or chronic,* and one complicated with disease elsewhere.

Owing to the risk of infective troubles alluded to below, every pains should be taken in the preliminary sterilisation. Not only are the eye brows to be shaved and skin thoroughly cleansed, but all the parts

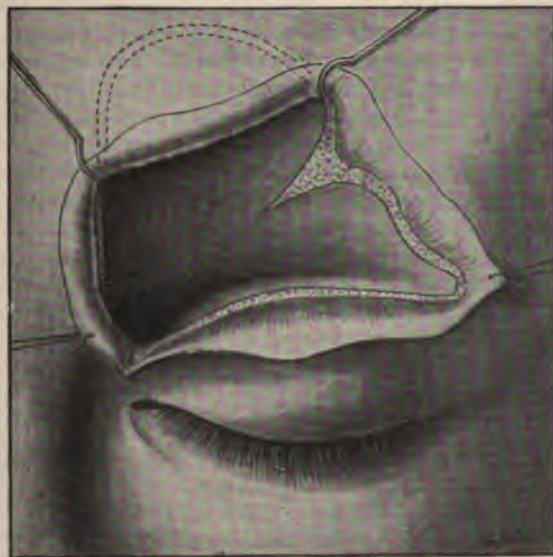
* I would here repeat the advice given at p. 286. Where the surgeon is about to operate for the first time on a frontal sinus, he should go over the field on a skull, fixing this in a vice.

FIG. 123.



Line of incision for radical operation on frontal sinus. (Tilley.)*

FIG. 124.

Cavity of sinus after removal of the anterior wall and of diseased mucous membrane.
The dotted line indicates upward extension of the sinus. (Tilley.)

* These figures are taken from a paper by Dr. H. Tilley (*Lancet*, May 21, 1904, p. 1414). To this and another practical paper by the same authority (*Brit. Med. Journ.*, Aug. 30, 1902, p. 582), and one by Dr. R. Milligan (*Brit. Med. Journ.*, Jan. 28, 1905, p. 171), I refer my readers.

adjacent to the field of operation are to be rendered as sterile as possible. This will include attention to the nose (with removal of polypi, and, if the needful experience be at hand, of the anterior part of the middle turbinal, to facilitate drainage), mouth, teeth (more particularly if the antrum requires simultaneous attention), and the lachrymal apparatus.

Ether* having been given and the posterior nares blocked by a sponge secured with tape, an incision is made curving from within outwards, commencing above the site of the internal palpebral ligament, *i.e.*, a little below the inner end of the eyebrow (Figs. 123 and 124). The incision should be immediately below the line of the eyebrow and extend to the junction of its middle and outer thirds. At its inner part it should pass down to the bone at once, the outer part being made more superficially at first, especially in slighter cases, so as to spare the supraorbital nerve if possible.

The incision is on no account to pass below the supraorbital ridge, which is always to be preserved. The periosteum having been cleanly divided † the soft parts are raised † with an elevator. The bone is then removed with gouge or chisel and mallet, or a quarter inch trephine, commencing on the supraorbital margin vertically above the inner canthus. No undue force is to be used with the mallet; the eye may be protected with a sterilised pad. The sinus having been opened, its extent is ascertained with a probe, and the opening enlarged chiefly in an upward and outward direction. The amount of bleeding during this stage varies; if considerable, it is best met by removing the bone as rapidly as is consistent with safety and then firm plugging. Suitable dossils of sterilised gauze and adrenalin solution (1 in 1000) should be at hand for this purpose, with smaller ones for cleansing the recesses of the sinus. As the bone is removed, the mucous membrane, normally thin and bluish in colour, now more livid red, thickened and friable, will protrude into the opening. When opened, muco-pus, pus, § granulation-polypi or exposed bone will be met with according to the duration of the case. On this depend the further steps of the operation. If it be a recent one dating to an acute infection from the nose,

* This operation is one in which it is probably safer to rely upon ether throughout. G. Fetterolf, of Philadelphia, has drawn attention (*Amer. Med.*, March 19, 1904) to a case in which cardiac inhibition took place reflexly from irritation of the peripheral fibres of the fifth nerve during an operation for chronic empyema of the frontal sinus. Each time that the curette was applied there was a marked diminution in the force and frequency of the pulse, together with distinct cyanosis. The path of the impulse is through the sensory branches of the fifth to the fourth ventricle, and so to the vagus. Fetterolf explains in this way some of those accidents which have occurred during dental and adenoid operations, and maintains that it is a safe rule never to use chloroform when the area to be operated on is supplied by sensory fibres of the fifth nerve.

† Dr. H. Tilley has found from an examination of 120 skulls that a quarter inch trephine applied to the lower margin of the frontal bone between the middle line, and one drawn vertically upwards from the internal angular process, will in all cases open the sinus, if one exist.

‡ Especial care must be taken to deal gently with the periosteum in cases where it will be needful to obliterate the sinus. In such cases this membrane plays an important part.

§ The amount of this in a sinus which has been discharging freely by the nose may be small. While there is no specific organism, the following have from time to time been demonstrated in pus from infected sinuses—streptococci, staphylococci, meningococci, pneumococci, and the bacilli of Pfeiffer and Friedländer (Milligan).

e.g., influenza, and if the sinus is a small one, it will be sufficient to remove the anterior wall sufficiently to admit of cleansing the sinus completely and finding the orifice of the fronto-nasal duct. A drainage tube is passed along this into the nose, the upper end being brought out through the lower and inner margin of the incision which is never to be closely sutured. These points will now be taken in detail. The anterior wall having been cut away the mucous membrane is first wiped clean with dossils of gauze, any granulation-polypi removed, but the membrane itself should not be removed in its entire thickness, the object of the operator being to get it into a condition to throw out healthy granulations and aid in the obliteration of the cavity. For this purpose pure carbolic acid or solutions of formalin, or zinc chloride (gr. 40—oz) should be applied. If the case be of any duration, it will be needful to scrutinise the cavity for any loculi or recesses in which infective material may lurk. In exploring these with a small spoon, especial care is needed in dealing with the inferior and posterior walls, the former on account of the meninges, the latter chiefly on account of the pulley of the superior oblique (p. 337). If, accidentally, any opening be made in the posterior wall, this must be at once plugged with sterile gauze wrung out of pure carbolic acid, until the operation is completed. According to Dr. Tilley, diverticula of the main sinus exist especially below the main sinus. Their openings are easily missed. The next step will be to find the fronto-nasal duct at the junction of the posterior and inner walls with a curved probe or small bougie. When this is found, the surgeon must decide for himself as to whether he will leave a tube in or no. My own opinion is that it is only in recent acute cases, where the sinus is a small one, where the operator is satisfied that it is left in a sterile condition, where the fronto-nasal duct is adequate, that it is safe to dispense with a tube. I should add here that my experience is limited to three cases of recent disease and one of chronic suppuration. In two of the recent cases, I left a tube in for the first thirty-six hours, and the healing was complete in ten days. In the third I omitted to use a drainage-tube, suppuration reappeared in a few days, necessitating re-opening of the wound and insertion of a tube. Very possibly, greater care in cleansing the cavity might have obviated the need of this step. While some writers consider it sufficient, in recent cases where the fronto-nasal duct is patent, to dispense with a tube and any plugging with gauze and to suture the wound completely, I believe it to be safer, owing to the uncertainty as to whether all sources, *e.g.*, intra-nasal, of infection have been removed, to use a small tube in these cases, bringing one end out through the lower part of the incision and the other through the nostril. If all is doing well, it may be removed on the second or third day and the remaining sutures, of gossamer salmon gut, now tied.

In chronic cases there can be no doubt on this question: the patency of the duct must be restored to ensure a medium-sized drainage tube being passed as above. To enable this to be done and at the same time to remove parts which are certain now to be involved (p. 329), the anterior ethmoidal cells which lie in front of the probe acting as a guide in the duct must be broken through and removed with a small gouge, curette and burrs. To enable this to be done efficiently, it

will be well in severe cases to prolong the skin incision carefully downwards and to detach the periosteum downwards and backwards. Attention must be paid at this stage to the pulley of the superior oblique. If this be detached cleanly and without damage, any after-trouble (*vide infra*) will be slight and temporary. Any interference with vision which may show itself for a few days, is more likely to be caused by inflammatory exudation.

In difficult cases passage of the tube and breaking down of the anterior ethmoidal cells will be facilitated by the introduction of the little finger through the nostril and the introduction by this route of small ring-shaped curettes. But it will be safer to do most of the work from above, the probe in the sinus being a guide as to the amount of bone which lies in front of it and which may be safely removed.

The ends of the drainage-tube should be placed as above advised, and it should carry a silk loop above to admit of its being replaced. When the essential point of free drainage is secured, the operator must decide, in chronic and advanced cases, as to the advisability of removing freely the anterior and inferior walls of the sinus. He will have explained to the patient that such obliteration is more likely to lead to a certain and less delayed cure, but at the cost of an evident depression. Where the decision is left to the surgeon, the size of the sinus, as manifested by a probe (the larger the cavity, the greater the disfigurement resulting), the age and sex of the patient, the extent of the disease, and especially the presence of caries, will guide him in coming to a decision. I would add one other indication here. In some cases no duct can be found by a probe; in a few, after most careful attempts, the surgeon may fail in securing a new and adequate track for drainage: in these cases the cavity should be obliterated, otherwise, caries, reopening of the wound and a persistent sinus are certain to follow. It need scarcely be added that in advanced cases there is additional urgency for attention to the details already given as to the need of removing all diseased tissues, finding any diverticula, and taking every precaution to leave the cavity in as sterile a condition as possible. Before the wound is dressed, all its recesses should be dried out, and wiped over again with pure carbolic acid, and any small plug which has been inserted in a possible opening in the posterior wall removed. The drainage-tube, which has its two ends projecting as indicated above, should have one or two openings in its upper part only. It is now syringed through, and the cavity lightly packed with sterile gauze, so as to absorb blood, etc., one end of this is brought out at the lower angle of the incision by the side of the tube. The outer part of the wound only is then sutured with gossamer salmon gut. Boracic acid fomentations are always to be preferred to dry, and a sealed dressing is, in my opinion, never to be employed, even in acute and recent cases. Finally, the plug in the posterior nostril is removed.

By some, india-rubber plugs—*e.g.*, Dr. Lack's—shaped like a Morratt Baker's indiarubber tracheotomy tube, are advised. I am well aware that it is easier to insist on adequate and prolonged drainage, than to ensure its attainment in all cases. In some, the tube causes irritation, in others it becomes blocked, and we are all aware that drainage-tubes may be sources of infection.

the importance of securing patency of the fronto-nasal duct, to make certain of the cure remaining thorough, is paramount. Irritation and blocking of the tube are best avoided by making a free passage for the tube to lie in, infection by the tube by remembering that keeping the skin about the wound and the nose as sterile as possible, is important after as well as before the operation.

The operative steps in the more ordinary cases of acute and chronic disease of the frontal sinus having been considered, it remains to refer to some *more complicated cases, i.e.,* those in which more than one sinus is involved. Where the disease is bilateral, the scarring will be less if the sinuses are treated by separate incisions. Where this method is adopted at one time, the operator must not be hurried when he deals with the second sinus, or the result is certain to be imperfect. A median inverted T-shaped incision may be made use of in men; judging from one case of mine the scar becomes much less noticeable with time, but this method gives less room. For this reason especially I should prefer the other method, but I should always prepare the patient for the need of two operations.

Of the other sinuses, disease of the ethmoid and antrum most frequently complicates that of the frontal ones.* Transillumination,† the number of polypoid masses, the amount of suppuration, plugging the upper nares after cleansing the middle meatus and noting whether pus comes into the nose below the plug or from above on its removal (this will not, of course, exclude the ethmoidal sinuses) may be of help here. The use of adrenalin solution with eucaine may diminish the bleeding, often troublesome in the manipulations needful here. Further, there may be the history of previous dental trouble. When the surgeon feels assured as to the coexistence of frontal and antral suppuration, he may be in doubt as to which sinus he will deal with first. Dr. Tilley (*Lancet*, May 21, 1904, p. 1416; *Brit. Med. Journ.*, Aug. 30, 1902, p. 585) is strongly of opinion that the upper sinuses should be dealt with first, as the pus may be formed above, the antrum merely acting as a reservoir. The surgeon will have an additional reason for following this advice in the fact that by waiting to see if operation on the upper sinuses suffices, he will be better able to deal with other mischief if this prove necessary, than if he had attempted to cope with several sinuses at one time. The chief types of combined sinus disease and the mode of their production are given by Dr. Lermoyez, of Paris (*Brit. Med. Journ.*, Aug. 30, 1902, p. 581).

Operations on the maxillary antrum are described below at (*q.v.*). I have said nothing on the subject of the sphenoidal sinuses; owing to their inaccessibility and important surroundings operative attacks

* It is a matter of comparative rarity to find only one sinus or one group of cells affected; in the vast majority of cases two or more sinuses are involved. Zuckerkandl, with his great and unique experience, never found a single case *post mortem* in which frontal sinus suppuration was uncomplicated with ethmoidal; and E. Fraenkel, in 146 necropsies, did not find one uncomplicated case of suppurative frontal sinusitis. (Milligan.)

† This refers to the antrum. The value of transillumination of the frontal sinuses, the lamp being placed beneath the inner third of the supraorbital arch, is disputed. Dr. Milligan considers the results to be so uncertain as to be unreliable. Prof. Goldmann, of Freiburg, claims that an exact image of the frontal sinus and information as to its development, etc., can be obtained by the X-rays, and describes his method (*Lancet*, Jan. 6, 1906, p.

here should be left to especially skilled hands. Possibly an exception may be made for cases where the finger passed into the naso-pharynx detects obvious caries on the *anterior* wall of the sphenoidal sinuses; where the mischief is less evident, where the orifice by which the mischief in these sinuses—caries, polypoid granulations—requires finding by a probe and needs enlarging, the general surgeon should leave these cases alone.

After treatment.—A varying amount of œdema and ecchymosis in the loose tissues of the eyelid is certain. In acute cases the tube may be removed from the nose on the second or third day, and the sutures left untied at the operation now adjusted, not too tightly. A sealed dressing may usually be applied at the end of seven or ten days. In chronic cases the after-treatment is, necessarily, much more prolonged. At the end of twenty-four or forty-eight hours, according to the state of the parts left and the course which the case is running, the gauze should be removed. If the above conditions are favourable, it need not be replaced, a strip only being now left in the lower angle of the wound to promote free drainage. When it is removed, assiduous attention will be required to irrigation, *e.g.* with hydrogen peroxide, or syringing, and the nose and mouth must be kept clean, *e.g.* with chinisol. The first changing of the drainage-tube should be left, if possible, until the third day, and is much facilitated by leaving silk attached to the tube originally left in position. It should always be withdrawn from above downwards. The drainage-tube should not be dispensed with until the discharge is scanty and serous looking. This often requires a period of four or five weeks. In one case of chronic disease, in a patient of 65, with a huge right sinus, typical eggshell crackling, and downward protrusion of the eyeball, it was seven weeks before the wound was closed, the drainage-tube being continued for a month. Two features of interest in this case were the inspissated, cholesteatomatous nature of the contents, and the fact that the sinuses communicated by an aperture as large as a sixpence. This allowed of the left sinus, much less affected, being dealt with without a second incision. As soon as it is safe to leave off the boracic acid fomentations, firm pressure with sterilised pads and a knotted bandage will be found helpful.

Possible Sequelæ after Operations on the Frontal Sinuses.—The chief of these are—1. Infective trouble. In spite of care, osteitis, lighting up into fresh activity of quiescent mischief in adjacent parts, meningitis and cerebral abscess are all grave possibilities to be borne in mind. Dr. Tilley (*loc. supra cit.*) mentions, with most helpful candour, two cases which ended fatally, the one five weeks, the other not until nine months after the operation. One of these had been performed by the method known as Luc's, in which a funnel-shaped tube is employed, with its wider end resting on the floor of the frontal sinus, while the external wound is completely sutured, a method which Dr. Tilley has abandoned. In the following case recorded by Dr. Gibson of New York (*Amer. Journ. Med. Sci.*, March, 1899, p. 305), the speedier onset of the fatal result and its explanation are instructive.

A patient who had been twice operated on for empyema of the left frontal sinus, without any drainage by the nose being established, came under his care with a discharging sinus at the seat of the former operations. The opening having been enlarged, the sinuses

were curetted, cleansed, and drained through the nose. Septic meningitis followed, and the patient died nine days later. The necropsy showed that the right frontal sinus communicated with the inner surface of the skull. The nature of the opening remains uncertain. Dr. Gibson points out that his case shows the necessity, in patients in whom both sinuses are affected, of emptying these by a median opening common to both, and not, by an opening placed laterally, draining one sinus through the other.

Dr. Milligan, in his large experience of operation in 40 cases, met with two deaths from infective meningitis and cerebral frontal abscess.

2. Persistence of the disease. This may be due to an incomplete operation, or to mischief in the opposite sinus, or in those of the ethmoid, antrum, etc.

3. Disfigurement. This, chiefly marked in cases where the sinus is chiefly developed antero-posteriorly, may, if persistent in young subjects, be probably remedied by the injection of paraffin (*q.v.*).

4. A form of diplopia, from injury to the pulley of the superior oblique: this is usually temporary and, with other minor sequelæ such as ecchymosis and altered sensation over the brow, needs no further mention.

5. Dr Milligan has noticed in several cases the development of a keloid scar some months after operation. This he attributes to the constant action of the fibres of the orbicularis palpebrarum preventing local rest to the tissues. In the same way he considers the movements of the platysma as responsible for the keloid appearance of scar after operations upon the neck. The ages of the patients and the time occupied by the healing are not mentioned, but there is no doubt that, in cases where primary union has been secured, scars in the neck, *e.g.*, after partial removal of the thyroid, may take on a keloid condition some time after an operation, in those no longer young.

CHAPTER III.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS.

OPERATIONS ON THE BRAIN.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS (Figs. 125 to 130).

Motor Area.—The motor area, or that part of the cortex in which lesions cause paralysis on the opposite side of the body, lies beneath the anterior half of the parietal bone. It may be said to be in form a parallelogram, about an inch wide, with its centre traversed obliquely by the fissure of Rolando.

Speaking succinctly, but perhaps with sufficient accuracy for practical purposes, paralysis or convulsions limited to one lower extremity need the trephine at the upper end of the opposite motor area, paralysis of the arm at the middle third, paralysis of the face at the lower third. The centre of speech lies (on the left side) at the lower and anterior angle, or a little below and in front of the area. Three applications of a trephine with chipping away of bone will expose the motor area for thorough examination; if the paralysis is distinct and limited, one or two applications will probably suffice to find the lesion. Where lesions are combined (p. 343), points intermediate between the respective centres must be exposed.

The following aids in finding the fissure of Rolando will be useful. I shall give several as it is always well to check one by others. It will be seen that they are very simple, easily remembered, and that they do not involve the calculation of angles, or the need of cerebrogoniometers or goniometers.

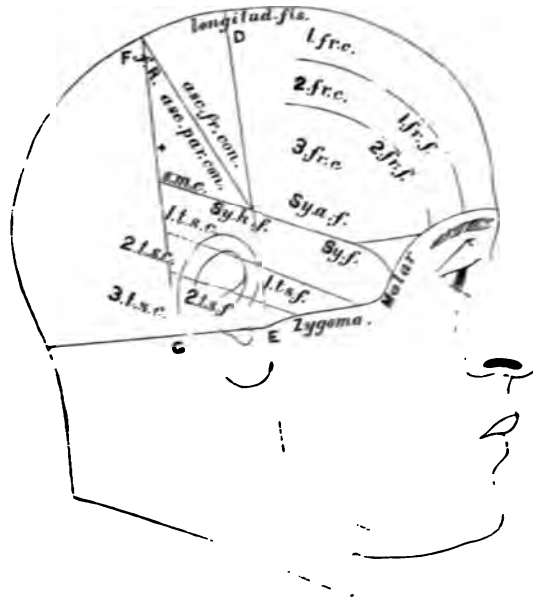
i. The upper end of the fissure is found about $\frac{1}{2}$ inch behind a point midway between the root of the nose and the external occipital protuberance; the lower end is about 1 inch behind the bifurcation of the Sylvian fissure. This bifurcation corresponds to a point 2 inches behind and $\frac{1}{4}$ inch above the level of the external angular process of the frontal bone.

ii. Mr. Godlee, in a case that has made history in the subject of operations for cerebral growths (p. 346), used the following simple method of exposing the fissure of Rolando in its middle third:

- (1) A line was drawn between the glabella and occipital protuberance.
- (2) At a right angle to this a line was drawn vertically downwards through the front of the external auditory meatus.
- (3) Parallel to the last a line was drawn vertically upwards at the

(4) From the junction of the lines 1 and 3, one was drawn diagonally downwards, reaching the second about 2 inches above the external auditory meatus. This was believed to represent the direction of the fissure of Rolando.

FIG. 125.



22-2

- (3) The lower third of this line C D is marked off at E, and
 (4) A line F E is drawn to the most prominent part on the outer border of the orbit at the outer end of the eyebrow. This gives the direction of the horizontal limb of the fissure of Sylvius.

The upper end of the fissure of Rolando is found at G, about a centimetre ($\frac{2}{5}$ of an inch) behind C, and runs from here in the direction G H,—H being on the line E F about 1 centimetre in front of E.

The Anderson-Makins method is largely used in America and the Continent. I have given several; while any of them can easily be remembered for emergencies, it is well to have others to check these by, owing to variations in different skulls and brains, when an important operation, *e.g.*, for cerebral growths or removal of a bullet is

FIG. 126.

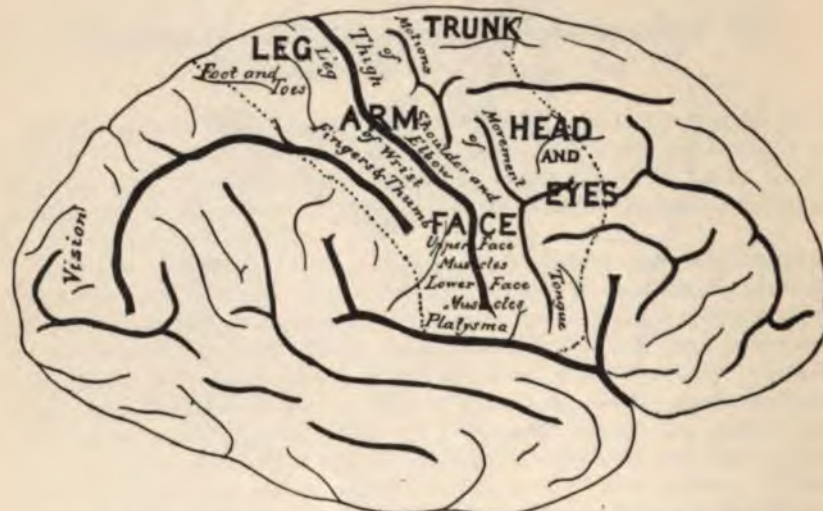


Diagram (after Eberstaller) of the fissures, convolutions, and the functional areas, with their extent on the right hemisphere of the brain. (Starr.)

being planned. Very slight inaccuracies in mapping out an area, especially when this is left, to be done rather hurriedly, just before the operation, may easily lead to incomplete exposure of the spot desired (p. 366).

With regard to the directions already given and those to follow, it must be remembered that the eminences and sutures of the skull, and the relations of the sulci and convolutions beneath to the cranial surface, are liable to variations.* I believe that the points here given will be found easily defined, and occupying a central position with regard to the brain beneath and its possible variations. The surgeon must be prepared to use his trephine and other instruments freely.

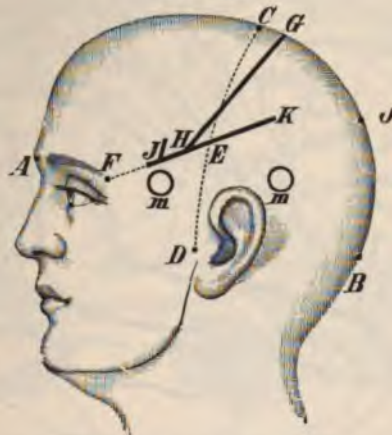
Position of the Chief Sutures (Figs. 129, 130).—After considering that most important part of the brain, the motor area, which lies under

* See papers by Prof. Turner, *Journ. of Anat. and Phys.*, vol. xviii.; Mr. Hare, vol. viii.; and Messrs. Anderson and Makins, *loc. supra cit.*

the parietal bone, it will be well to recall the landmarks of the chief sutures which are met with in that region. The *coronal suture*, the anterior limit of the parietal bone, may thus be traced. The point where it leaves the sagittal suture, the bregma, may be found by drawing a line from a point just in front of the external auditory meatus straight upwards on to the vertex; from this point the coronal suture runs downwards and forwards, speaking roughly, to the middle of the zygomatic arch, or, more exactly, to join the temporal part of the great wing of the sphenoid, which it meets $1\frac{1}{2}$ inches above the zygoma, and not quite an inch behind the external angular process of the frontal bone.

Under this suture lie the posterior extremities of the three frontal convolutions (Fig. 129), for the frontal lobe lies not only under the frontal

FIG. 127.



The method used by Mr. Anderson and Mr. Makins to determine the fissure of Rolando, *G H*, and the fissure of Sylvius, *F K* and *J*. *m m* indicate the sites of trephining for the two divisions of the middle meningeal artery (p. 264). *F*, External angular process of the frontal bone. *K*, Termination of the Sylvian fissure. (Tillmanns.)

bone, but extends backwards under the anterior part of the parietal, the fissure of Rolando, which forms the posterior boundary of the frontal lobe, lying from $1\frac{1}{2}$ to 2 inches behind the coronal suture.

The *occipito-parietal or lambdoid suture*, the posterior limit of the parietal bone, will be marked out by a line which starts from a point $2\frac{3}{4}$ inches above the external occipital protuberance, and runs forwards and downwards to its termination, which will be found on a level with the zygoma, $1\frac{1}{4}$ inch behind the meatus.

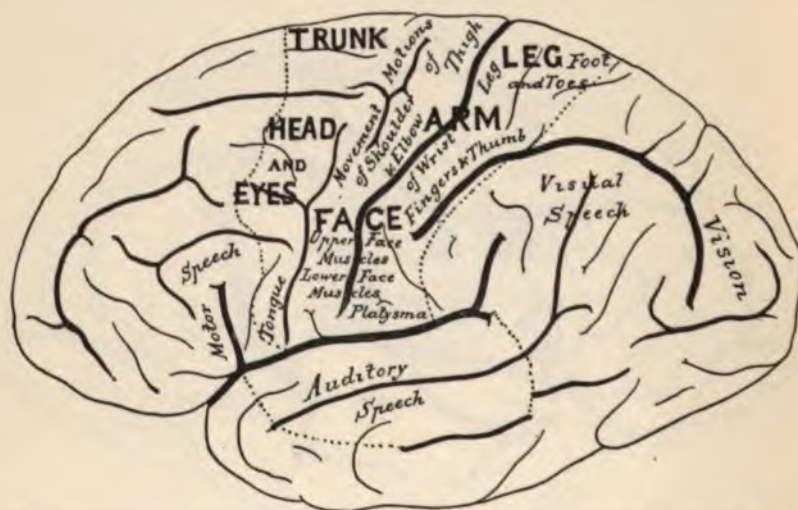
As the occipital lobe is not limited to the upper portion of the occipital bone, but extends forwards under cover of the posterior part of the parietal, the parieto-occipital fissure lies about $\frac{3}{4}$ inch in front of the apex of the lambdoid suture (Fig. 129). But this varies a good deal according to the ossification of the squamous part of the occipital.

The *squamous or squamoso-parietal suture* is not so easy to mark out,

owing to the irregularity of its curve and variations. Its highest point is usually $1\frac{3}{4}$ inch above the zygoma (Fig. 129).

The Sylvian fissure, which separates the temporo-sphenoidal from the parietal lobe, passes from below obliquely upwards and backwards across the line of this suture near its middle (Fig. 129), the temporo-sphenoidal lobe not only lying under the squamous and great wing of the sphenoid, but passing upwards under cover of the lower part of the parietal. The fissure of Sylvius (Figs. 125, 129) is found by drawing a line from a point $1\frac{1}{4}$ inch behind the external angular process of the frontal bone to a point $\frac{3}{4}$ inch below the most prominent part of the parietal eminence. Measuring from before backwards, the first

FIG. 128.



A diagram, similar to that shown in Fig. 126, of the left hemisphere. (Starr.) The auditory-speech or word-hearing centre is placed too far forwards.

$\frac{3}{4}$ inch of this line will represent the main fissure, and the rest its horizontal limb. The ascending limb will start 2 inches behind and slightly above the external angular process, and run vertically upwards for about an inch.

The following practical points are given by Prof. Nancrede, following M. Lucas-Championnière (*Intern. Encycl. Surg.*, vol. v. p. 90).

(1) Monoplegia or spasms limited to one member, or a portion of one member, indicate limited lesions. If the lower limb be affected, the upper portion of the ascending parietal and frontal convolutions (Figs. 125, 126, 128, 129) is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

(2) With paralysis of the arm and leg, the lesion probably involves the upper two-thirds of the ascending convolutions, with the paracentral lobule. The trephine should then be placed at the upper part of the line, a little lower than in the former case, and the opening enlarged downwards.

(3) Paralysis of the upper extremity alone probably indicates injury

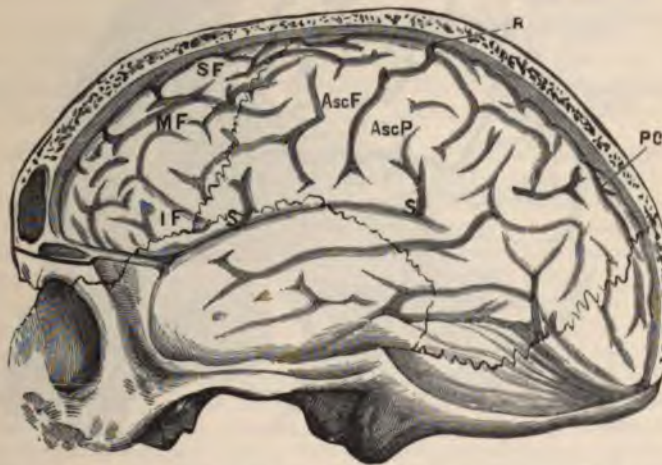
to the middle third of the ascending convolutions and the trephine should be applied a little in front of the middle third of the fissure of Rolando.

(4) Paralysis of the lower part of the face points to a lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal.

(5) In simple aphasia the trephine-crown should be removed lower down still, in front of and below the lower extremity of the left fissure of Rolando.

(6) In most cases many centres are affected, and consequently the surface to be exposed is much larger. The following combinations are

FIG. 129.



The above view of the brain *in situ* shows the relations of the surface convolutions to the regions of the skull. *R*, Fissure of Rolando, separating the parietal from the frontal lobe. *PO*, Parieto-occipital fissure between the parietal and occipital lobes. *S, S*, Fissure of Sylvius, separating the temporo-sphenoidal from the frontal and parietal lobes. *SF, MF, IF*, The superior, middle, and inferior frontal convolutions. *Asc.F.*, Ascending frontal convolution. *Asc.P.*, Ascending parietal convolution. The outlines of the coronal, squamoso-parietal, and lambdoid sutures are also shown. (After Turner.)

those usually met with: Paralysis of face and aphasia; aphasia and paralysis of the arm; paralysis of the arm and face; paralysis of the upper and lower extremities.

Lesions which irritate a localised area of the cortex, *e.g.*, a spicule of bone, a meningeal hæmorrhage, a localised meningitis or a growth produce spasms in the corresponding groups of muscles on the opposite side of the body which are supplied by the cortical centres irritated (Jacksonian Epilepsy). The irritation may involve adjacent centres, causing more widespread, and even general convulsions. Lesions which destroy any area of the cortex produce paralysis on the opposite side of the body, corresponding to the position and extent of the area destroyed. A few special cortical centres must be remembered. Broca's convolution, in the posterior extremity of the left inferior frontal

convolution, corresponds to a point three fingers'-breadth vertically above the middle of the zygomatic arch. This centre governs the muscular movements concerned in speech, and lesions of it cause "motor aphasia." The auditory-speech, or word-hearing area, through which spoken words are received, lies in the middle of the first temporo-sphenoidal convolution. Lesions here produce "word deafness," the patient being unable to understand spoken words. The visual speech or word-seeing centre by which written words are appreciated lies in

FIG. 130.



The chief convolutions and fissures on the outer surface of the brain, together with the outlines of the sutures and bones beneath which they lie. Diagrammatic. (After Roberts, of Philadelphia.)

the angular gyrus at a point higher up and behind the last (Fig. 128). If this centre be destroyed power to read words is lost. All the above are situated on the left side in right-handed patients.

The cortical centres for vision lie near the calcarine fissure on the inner aspect of the occipital lobes, below the level of the parieto-occipital fissure (Fig. 129). Each is a half-vision centre and receives fibres from the same side of each retina. Lesions of one centre produce "homonymous hemianopsia," or inability to see objects situated on the side opposite to the lesion.

PRACTICAL VALUE OF CEREBRAL LOCALISATION.

I propose to give instances of this under the following headings:—

(A) In head injuries; (B) In brain growths.

(A) **Cerebral Localisation in the Diagnosis and Treatment of Injuries to the Head.**—A typical case, in which localisation may help the surgeon in trephining, would be one in which the injury is limited

to the cranium, and is followed immediately by paralysis. Secondary or tardy paralysis may be the result of later inflammatory processes.

M. Lucas-Championnière (*La Trépanation guidée par les Localisations cérébrales*, p. 107) gives this interesting case :

A man was found in the street with slight paralysis of the right arm, but sensibility perfect. There was a small superficial cut, $\frac{1}{2}$ inch long, over the left parietal eminence. Five or six days later the patient became stupid and unable to swallow, and convulsions,* increasing in violence, and involving all the body, save the right forearm and hand, set in. Suspecting a fracture of the inner table, M. Lucas-Championnière trephined at the site of the wound, and found a fine fissure just in front of this ; there was a slight depression of the fragments, which were wedged tightly together. After the operation the convulsions ceased, and a good recovery took place, with use of the right arm. The fracture was proved by measurements to be over the middle and lower part of the fissure of Rolando, considerably in front of the scalp wound.

The following case of cerebral lesion (Intracranial Sub-dural Effusion of Blood), diagnosed from motor symptoms alone, was given by Sir W. Macewen in his most striking address at the Glasgow meeting of the British Medical Association (*Brit. Med. Journ.*, Aug. 11, 1888) :

A boy had, consecutive to a fall six days before, convulsions beginning in the left side of the face, gradually involving the left arm and subsequently the left leg, consciousness being preserved. Paresis of these parts remained, though sensation was unimpaired. The parts were always affected in the same general order, and the convulsions, persisting, finally became general, with loss of consciousness. These motor phenomena indicated a lesion on the right side of the brain, pronounced at the middle and lower part of the ascending convolutions, as the face and arm centres were the first to show evidence of stimulation. The lesion was evidently of an irritative kind, such as might be caused by a bone spicule driven into the brain, or by pressure on its surface. It was clearly not destructive, *e.g.*, a severe cerebral contusion. It was resolved to expose the lower part of the fissure of Rolando. The head being shaved, a scarcely perceptible irregularity was detected near the coronal suture. Trephining was performed at a point slightly behind the auriculo-bregmatic line, and midway between the auditory meatus and the vertex. This happened to correspond to the posterior extremity of a fissure which ran across the coronal suture. There was no extra-meningeal hæmorrhage, but the dura was very dark. On opening this 2 ounces of clotted blood escaped from the sub-dural cavity. There was no recurrence of the fits, and the patient survives in perfect health.

Case of Traumatic Aphasia successfully treated by removing Blood-clot from the interior of the Cerebrum :†

The patient had been struck on the head with a penknife six days before admission. At that time he had difficulty in speaking correctly, which had increased somewhat, and pain in the left side of the head, but no paralysis or loss of sensation. A small scar was found over the left squamous bone, 2 inches from the external angle of the orbit, and $\frac{3}{4}$ inch above the zygoma. Both forms of aphasia (motor, speaking ; and sensory, word-blindness) were, to a certain extent, present. Five days later the scar was explored, and a wound of the squamous bone, in size and shape likely to have been produced by a small penknife, found, and cut out in a trephine-circle. The knife had penetrated the dura and brain, the large posterior branch of the middle meningeal just escaping. The dura being opened, a sinus-forceps was gently passed along the brain wound, and, on separating the blades, a blood-clot presented, and was gradually extruded by brain-pressure. Some more was removed by the forceps and by a stream of weak mercury perchloride solution. A

* Convulsions in themselves are only an indication for interference when they are localised and persist, and especially if they alternate with paralysis of the same muscles.

† Sir C. B. Ball, *Trans. Roy. Acad. of Med. Ireland*, vol. vi. p. 155.

drainage-tube was inserted. On the evening of the same day the aphasia was much improved. Next morning the patient was again more aphasic, and it was found that the tube had become blocked. On freeing it, much fluid with broken-down clot escaped, and the power of speech improved. The patient recovered uninterruptedly, regaining completely his power of writing, reading, and speaking. Sir C. Ball believed that the knife had penetrated the superior temporo-sphenoidal gyrus, traversed the Sylvian fissure, and probably injured Broca's convolution.

(B) **Cerebral Localisation in the Diagnosis and Removal of Cerebral Growths.**—Amongst the cases which have been published there have been very few to surpass in helpfulness, from the completeness of the details and the accuracy of its reasoning, one of the most epoch-marking of the cases submitted to modern surgery—viz., that trephined by Mr. Godlee for Dr. Hughes Bennett in 1884 (*Med.-Chir. Trans.*, vol. lxxviii. p. 244), an abstract of which is given below :

A man, aged 25, had, four years before, suffered from slight concussion from a blow on the left side of the head. A year later, there first set in twitchings in the left side of the mouth and tongue, paroxysmal and irregular in occurrence. Some months after, fits began, with loss of consciousness and general convulsions. This condition lasted two and a half years; and six months before admission, twitchings of the left hand, followed shortly by weakness of the left fingers, hand, and forearm, were noticed. For three months these had prevented his using his tools. During this last period there had been twitchings of the left leg, which had also been getting weak. There was nothing abnormal in the skull or scalp. Vision was normal, but optic neuritis was present on both sides, most marked on the right. Hearing was less acute in the right ear. There was now complete paralysis of the left fingers, thumb, and hand, the elbow movements were very limited, those of the shoulder impaired. There was no rigidity or wasting of muscles. The toes of the left leg did not clear the ground in walking. There was persistent vomiting and retching, with attacks of lancinating headache, rendering life intolerable. Large doses of the iodides were fruitless.

An operation being decided on, the motor area and the diagonal line representing the fissure of Rolando were mapped out by the method already given at p. 338. Theoretically, in order to hit the middle of the fissure of Rolando, the centre of the trephine should have been placed about $\frac{1}{2}$ inch behind the diagonal line, and about $1\frac{1}{2}$ inch from the median longitudinal line. As, however, there was a tender spot on the scalp 2 inches anterior to this, the first opening was made (with a trephine 1 inch in diameter) between the two.* The dura mater was normal; after a crucial incision was made in it, the brain was thought to bulge abnormally, and to be rather more yellow than usual, otherwise it was healthy. A second crown was cut away, overlapping the first, external to and slightly in front of it, and the angles of bone rounded off with a chisel and hammer, the brain being protected with a copper spatula. These two openings were then joined by one posterior to them, and the edges being chipped away, a triangular aperture was left measuring 2 by $1\frac{1}{4}$ inches. The dura mater was opened, and a surface of brain exposed nearly equal in size to that of the skull-opening. Occupying most of this space, and crossing it obliquely from above and behind, downwards and forwards, was a convolution. Into the centre of this convolution an incision about $\frac{1}{4}$ inch in length was made with a scalpel. From $\frac{1}{4}$ to $\frac{1}{2}$ inch below the surface lay a transparent, lobulated, solid tumour, thinly encapsuled, but quite isolated from the surrounding brain substance. The incision into the cortex being prolonged, the sides of the growth were easily separated by a spatula of steel, readily bent into any shape. The superficial surface of the growth being thus isolated, this portion was removed with the finger; as part now broke away, the deeper portion was enucleated with a sharp spoon, the scraping being continued till apparently only healthy brain matter remained. This caused rapid welling-up of blood into the cavity,

* The centre of the opening was $1\frac{1}{4}$ inch from the middle line and $\frac{1}{2}$ inch behind a line drawn vertically upwards from the meatus of the ear.

which would have held a pigeon's egg. Sponge-pressure failing, the hæmorrhage was finally arrested with the electro-cautery. The dura mater was drawn together with sutures, and a drainage-tube inserted beneath it. Elsewhere the skin was brought accurately together. Antiseptic precautions including the spray, were used throughout. The anæsthetic, chloroform, was taken well.

The wound was not dressed till the third day, when the discharge had a distinctly putrefactive smell: the scalp near the wound was somewhat cedematous. The next day wet boracic acid dressings were applied. There was hardly any trace of smell, but a hernia cerebri as large as half an orange was protruding through the lips of the wound. There were no twitchings of limbs or face, no headache. The patient was bright and cheerful, with a good appetite. The hernia cerebri, however, increased, and on the eighth day, having reached the size of half a cricket-ball, was snipped away with scissors, the parts removed consisting chiefly of granular matter and clot, with, apparently, little true cerebral structure. The cut surface was treated with a strong solution of zinc chloride and iodoform, and a cap of block-tin applied. The hernia cerebri again increased somewhat, but all seemed to be doing well, when, on the twenty-first day, a rigor appeared, headache followed and vomiting, then restlessness, sleeplessness, and gradual sinking about four weeks after the operation.

At the autopsy extensive arachnitis was found. The parietal area appeared to have fallen in; in its centre, and occupying the position of the fissure of Rolando, was the wound in the brain. The destruction of the cerebral cortex involved nearly all the ascending parietal convolution, the upper part of the ascending frontal, and the anterior third of the supra-marginal gyrus. The extent of softening was not great, but it was difficult to tell this accurately, as the brain had undergone the process of hardening. The growth was a glioma, of the size of a walnut.

In the comments on the case, most interesting remarks are grouped under the following heads: (1) Diagnosis. (2) Surgical treatment. (3) Clinical phenomena after the operation. (4) Revelations of the necropsy physiologically and pathologically considered.

These will well repay most careful perusal; only the chief points can be given here.

(1) *Diagnosis*.—A brain growth on the right side was diagnosed in this case on the following grounds:—Slow progress, uncontrollable vomiting. Violent pains. Double optic neuritis. It was thought to occupy the cortex because certain motor tracts were implicated in definite order, because paralysis was present without loss of sensibility, and above all because of certain paroxysmal seizures of local convulsions occurring without loss of consciousness, eminently suggestive of irritation of the grey matter.

In this case there was complete paralysis of the fingers and hand, with inability to pronate and supinate the forearm, there was partial paresis of the movements of the elbow, and weakness of those of the shoulder-joint. There was also slight paresis of the leg and one side of the face. Accompanying all these there were paroxysmal convulsions in all these regions, occurring either singly or in definite order one after the other. These phenomena were to be accounted for by an extensive but not absolutely complete destruction of the motor centres of the fingers, hand, and forearm, with slight encroachment on and irritation of those of the face, upper arm, and leg. A very definite localisation was thus permitted, and the tumour was pronounced to have occupied the whole thickness of the middle two-fourths of the ascending parietal convolution, and a portion of the adjoining upper half of the ascending frontal convolution.

The growth was proved to be limited by the fact that the centres of

the leg above, of the face and tongue below, of sight behind, and of the movement of the eyeballs in front, were not seriously involved. It could not have exceeded 2 inches in diameter, and proved to be a glioma, of about the size of a walnut, lying obliquely in the fissure of Rolando. As to the probable nature of the tumour, the age of the patient, the absence of syphilis, and the slow progress, suggested glioma.

(2) *The Operation.*—Mr. Godlee considered that the use of a larger trephine might be advisable in similar cases. One convolution only being exposed during the operation, there was at the time some question as to whether it was the ascending frontal or parietal. This doubt arose from the circumstance that in the attempt to approach the tender spot the theoretical position had been slightly departed from. After death, however, it was apparent that the convolution which had been incised was that in which from the first the disease had been diagnosed to exist—viz., the ascending parietal. There was no external appearance of disease about this part except that it seemed swollen, less glossy, and less vascular than natural. An incision into it showed the morbid growth to be immediately under the surface, and almost completely involving the entire thickness of the cortex. In clearing away the superficial parts of the growth a small spatula, neither sharp nor blunt, and so tempered that it would keep any shape given to it, was found most serviceable. It may be questioned whether it was advisable to arrest the hæmorrhage from the interior of the wound by means of the galvano-cautery, as the bleeding was not severe and would no doubt have become arrested by natural means. The use of this instrument appears to have brought about the putrefaction which was the cause of the inflammation and consequent hernia cerebri. It may be doubted if the putrefaction was ever completely subdued; the fact of the meningitis occurring at last, and that of smell having again become apparent after the attempt at removal of the second protrusion, point probably to a continued septic infection. As to the hernia cerebri, it was remarkable in the first place that the discharge continued for so long to be so copious and so watery, as to suggest the idea of its being cerebro-spinal fluid.* Secondly, there was a difficulty in shaving it off owing to the enormous size of its base and the danger of serious hæmorrhage.

(3) *Clinical Phenomena following the Operation.*—The patient lost his headache, vomitings, and violent twitchings in the limbs; even the double optic neuritis markedly diminished. The only change which followed the operation was completion of the paresis of the upper extremity, evidently due to the unavoidable destruction of the remaining arm-centres in the removal of the tumour. Coincident also with the formation of the hernia cerebri came fresh symptoms, in the shape of paresis of the left leg and partial anæsthesia of one-half of the body. These were probably due to the effects of simple pressure, and possibly to the subsequent secondary softening of the conducting fibres caused by it.

* Whether the lateral ventricle had been opened into, the post-mortem examination did not prove conclusively. There was no collection of foreign matter in its interior; at the same time the softening had extended close to it.

(4) *Revelations of the Necropsy.*—The brain was, practically, everywhere healthy except over the area injured by the operation and in the membranes in the immediate neighbourhood. The meningitis was due to irritating matter from the interior of the wound flowing downwards between the layers of the arachnoid, and accumulating at the base of the brain. The local inflammation of the wound had opened out the parts, and separated the adhesions so as to allow the discharge to percolate into the cranial cavity, but not till three weeks after the operation.

The following "Case of Subcortical Cerebral Tumour treated by Operation," by Dr. Beevor and Mr. Ballance (*Brit. Med. Journ.*, 1895, vol. i. p. 5), should be studied in the original. As would be expected from the authors' reputations, it is most helpful from its scientific accuracy and fulness of detail:

(1) A woman, æt. 39, had, twelve months before admission, been gradually attacked by paralysis, involving successively the right ankle, the knee and hip; it extended after the lapse of seven months, to the right hand, and then to the whole of the upper extremity. (2) The classical symptoms of intracranial pressure, headache, vomiting, and optic neuritis were present. (3) The mental condition gradually deteriorated. (4) There was some loss of sensation, affecting the right limbs chiefly, while the face entirely escaped. (5) There was no history of tubercle or syphilis. (6) Under anti-syphilitic remedies, taken for over six weeks, the patient's condition grew worse. The progressive nature of the hemiplegia, together with the classical symptoms of intracranial pressure, optic neuritis, headache, and vomiting, made the diagnosis of a tumour almost certain. In settling its exact position, whether in the cortex, the centrum ovale, or the internal capsule, the following symptoms of lesions in these different parts were considered: "(a) The type-symptoms of involvement of the cortex are: 1. Jacksonian epilepsy, the aura or the initial movement being represented in the part of the cortex first involved in the tumour. This is followed later by a permanent paralysis of the same part, which progresses in a definite order. 2. Corresponding to the paralysis of the limb segments there is change of sensibility. Light touches may not be felt, but if they are, they are not properly localised. Loss of muscular sense, so that the patient is not cognisant of the position or the passive movements of his limb. 3. Occasional tenderness of the skull over the site of the tumour. (b) The type-symptoms of involvement of the internal capsule are: (1) Absence of Jacksonian fits. (2) The paralysis is progressive, but extends more rapidly than a cortical paralysis, owing to the closer gathering of the fibres. (3) Loss of sensation tends to affect the whole of the opposite half of the body, including the head, to be more complete than in cortical lesions, and to involve all forms of sensation. (c) The type-symptoms of involvement of the centrum ovale can only be determined by a process of exclusion, and they probably are modified according as the growth extends towards the cortex or towards the internal capsule. (1) Absence of fits. (2) Absence of tenderness of cranium. (3) Progressive paralysis and progressive loss of sensation, either of cortical or capsular type. In comparing the present case with the symptoms of the above types, the internal capsule appeared not to be involved in the tumour on account of the fact that the anæsthesia corresponded to the paralysed parts, and was not complete; further, localisation was imperfect, and muscular sense was lost, the face escaping completely. The gradual march of the paralysis, too, pointed away from the internal capsule. The diagnosis therefore rested between a cortical and sub-cortical lesion. It is first to be noted that the patient had never had a fit, and although it is known that a cortical tumour may be present for many months without giving rise to a fit, still the general rule holds good that the absence of fits is against the diagnosis of cortical lesions. Secondly, there was never at any time any tenderness of the cranium, which, if present, makes for the diagnosis of a superficial cortical lesion involving the dura. Thirdly, the sensation was of cortical type, and did not assist in the differentiation of a cortical from a subcortical growth, but it pointed to the lesion being nearer to the cortex than to the internal capsule. Fourthly, the sequence in

which the different parts of the brain were involved, as shown by the march of the paralysis, was also instructive." I must refer my readers to the original for further minute details by Dr. Beever. I have found space for those already given because of the importance of settling, from an operative point of view, whether a growth is cortical, subcortical, or in the internal capsule. The conclusion having been arrived at that the growth was subcortical and did not involve the internal capsule, the following operation was performed by Mr. Ballance, July 11th, 1894. The scalp having been prepared in the usual way, chloroform was given, and a large Horsley's U-shaped flap was thrown down on the left side. This flap included the periosteum, and allowed of the exposure of the coronal and sagittal sutures, about one inch of the posterior part of the frontal bone, and practically the whole of the parietal bone, with the exception of the anterior inferior angle, and the part immediately adjacent to the lambdoid suture. The portion of bone to be removed was then marked out by means of a large saw. It was in shape a parallelogram, whose anterior and posterior borders, running parallel with each other, were planned also to run parallel with the sulcus of Rolando. The anterior border encroached a little on the frontal bone at its lower end. The upper border of the parallelogram corresponded with the sagittal suture, and extended along it from the bregma for fully three and a half inches. The lower border was parallel with the upper and two and a half inches below it. The portion of bone removed would thus include the parietal eminence, and would allow of the free exposure of the upper part of the motor cortex, especially of the toe and ankle centres at the upper extremity of the ascending parietal convolution, which it was desired to thoroughly examine. The removal of the bone thus marked out was accomplished by the aid of the same large saw, by means of which it was divided up into small quadrangular pieces by vertical and horizontal cuts. These pieces were then easily raised from the dura by an elevator. As soon as one piece had been removed, the use of strong bone-cutting forceps facilitated the final separation of the pieces into which the bone had been mapped out by the saw. Along the upper boundary of the opening the final removal of bone was accomplished in part by disarticulation at the sagittal suture. The dura was exposed without injury, and the middle meningeal artery lay upon it without having been wounded. The dura bulged considerably into the opening. As it was clearly desirable to perform the operation in two stages, the edges of the scalp wound were now brought together by horsehair sutures, and the dressings applied. Six days after the first operation, the patient having completely recovered from its effects, chloroform was again administered. The wound was found united by first intention, but its edges were easily separated by the handle of a knife after the sutures had been cut. The flap was again thrown down, no bleeding occurring, and wrapped up in an antiseptic dressing. A little clot was lying on the dura. As large a square dural flap was next cut and folded down over the scalp flap. The cortex thus exposed was bulging, and, especially over the upper part of the ascending parietal convolution, presented a mottled and unnatural appearance. This mottling may have been due to minute ecchymoses produced during the removal of the bone a week before, or to malignant invasion of the cortex. The former alternative appeared the more probable. On palpation, no area of special resistance indicating the site of the tumour could be discovered, but on exploring the mottled ascending parietal convolution with the finger, the cortex, being here greatly thinned, was broken through, and the tumour, of a whitish-grey colour, was seen. As the ruptured cortex receded, the tumour appeared to be discontinuous with the brain substance, and an attempt with the finger and the handle of a sterilised silver spoon was made to shell it out. This, however, was impossible, as it was discovered to be continuous with and infiltrating the surrounding cortex, and also the substance of the hemisphere about an inch below the surface and towards the front and middle line. The consistence of the tumour was semi-gelatinous, softer than the normal brain substance, and it was found easier to remove it with a silver spoon than in any other way. A considerable hæmorrhage occurred at the time, and as it was not well controlled by filling the cavity with cotton-wool, a series of fine silk threads were passed through the cortex for a depth of about three-quarters of an inch all round the affected area, except about an inch at the median line, and tied so that all the vessels in the affected area were controlled. The area was about two and a quarter inches in diameter. A free incision was then made through the cortex, all round, just within the line of ligature, and all the included part, brain and tumour, was taken

away by means of the spoon. The tumour extended to the median surface of the hemisphere, and so a part of the marginal convolution and the quadrate lobule was removed, the falx being clearly exposed. In this way as much of the tumour as was visible was removed, but as the line of junction of healthy and diseased tissue was so indeterminate, it is not possible to say that the whole tumour was excised; it is, indeed, probable that it was not. At the close of the operation, the brain presented a large cup-shaped cavity, nearly two inches deep, and the size of half an orange. It is probable that the area removed comprised the upper part of the ascending frontal and parietal convolutions, the anterior part of the parietal lobule, and the adjacent portion of the marginal convolution. When all bleeding had ceased, the dural flap was very carefully stitched in position with fine silk. No bone was replaced. The scalp flap was brought in place by many horsehair sutures. The antiseptic employed during the operation was solution of mercuric perchloride (1 in 2000). The brain wound was constantly irrigated with the solution so as to keep it clear of blood. No marine sponges were used, and the operation area was kept free of blood, not by mopping or touching the brain, but by the stream of fluid. The patient was much collapsed when put back to bed, but this condition soon yielded to the ordinary treatment. The wound only needed dressing twice. The growth was found to be a mixed sarcoma with round and spindle cells. Aphasia and loss of power in the extremities of the right side followed the operation for a time. Four months after the operation, the patient was restored to her normal mental condition. Speech perfect. No headache. Some rigidity of joints of right hand and wrist, but movements on the whole good and useful. In the right lower limb loss of power over toes and ankle. Patient can walk without assistance or a stick, swinging the right leg, catching it on the ground sometimes.*

The following case, though not in the motor area,† is of great interest from the size of the growth, its less usual site, and the complication of hæmorrhage, eventually fatal:

The patient was affected with cerebral symptoms extending over eighteen months, consisting of left hemianopsia, which could only be accounted for by a destructive lesion in the neighbourhood of the gyrus cuneatus of the right occipital lobe, and locomotor disturbances, which appeared to be due to the pressure effects of a tumour on structures below the tentorium, and implied a growth of considerable size. Operation having been decided upon, a U-shaped flap was raised, and a 1-inch trephine applied at 1 inch above the occipital protuberance, and the same distance from the middle line, beyond the limits of both the longitudinal and lateral sinuses, and the bone removed until an oval opening $2\frac{1}{4}$ by $2\frac{1}{2}$ inches was made, exposing a dura mater of a deeper hue than normal; section of this exposed the tumour, the outlying edges and base of which could not be reached in spite of further removal of the cranium; it was therefore incised and some of its softened granular and fatty-looking contents forced out. Its size was now somewhat diminished, and the forefinger could be passed between the cranium and tumour, and by its aid the delicate cellular attachments that held the mass in place were felt to yield easily, enucleation now became possible, and the base was finally reached. By next drawing the finger gently but firmly towards the cranial opening, the tumour was torn nearly completely in two, and its outer half lifted out; then the inner part was separated from the falx with the help of the finger-nail and withdrawn. Inspection of the mass showed that the tumour had been entirely removed, and that its probable attachment had been towards the posterior border of the falx; the tumour was a spindle-celled sarcoma, weighing $5\frac{1}{4}$ ounces, measuring $3\frac{1}{4}$ inches long by $2\frac{1}{4}$ inches wide, and being $8\frac{1}{4}$ inches

* I must refer my readers to the original paper for a full statement of how far the usefulness of the limbs was impaired after the operation. The details are given with candid accuracy. In answer to my inquiry, Mr. Ballance informed me that the patient was living at the end of 1899, or more than four years after the operation, but there was indication of return of the growth. Her death followed soon after.

† "Removal of a Large Sarcoma, causing Hemianopsia, from the Occipital Lobe of the Brain," by Dr. Birdsall and Dr. Weir: *New York Med. News*, April 16, 1887; *Annals of Surgery*, vol. vi. No. 2, p. 149.

at its greater circumference. The falx was crowded over towards the left, and the tentorium depressed; two bleeding points were observed, one being in the region of the straight sinus, although not free enough for that vein, and probably belonging to the pedicle of the growth, while the other was apparently arterial. It being found that the hæmorrhage could be checked by direct pressure, the cavity was packed with 5 per cent. iodoform gauze, not too tightly, as it was assumed that the released brain would contribute additional pressure, and the ends of the strips were allowed, for easy extraction, to protrude from the lower angle of the scalp wound; the dura was partly united over the gauze by several loose sutures instead of being brought closely together, and the scalp wound closed with catgut sutures: a rubber drainage-tube being introduced under the skin up to the skull opening, and over these sublimated and iodoform peat bags were secured with gauze bandages. The patient soon showed symptoms of hæmorrhage, which could not be controlled by further packing, and death ensued thirteen hours later. Dr. Weir, in another case, would favour the application of hæmostatic forceps to the bleeding points, retaining them in place for twenty-four or forty-eight hours.

QUESTIONS ARISING BEFORE OPERATION ON A CEREBRAL GROWTH.

The chief of these are: (A) The existence of a growth. (B) The site of the growth. (C) The depth of the growth. (D) Is it single or multiple? (E) Its nature. (F) The conditions which justify operative interference and the probable results of this step.

The above points, and the first five especially, must be decided with a physician; and it is to be hoped in future that physicians will invoke, at least, the opinion of the surgeon earlier than has hitherto been the case. In too many cases of cerebral growth the operation has only been resorted to as a forlorn hope, a fact which is always to be considered when the mortality from operation in these cases is estimated.

(E) *The Nature of the Growth.*—Before dealing with *growths* of the brain proper I will allude here to those *springing from the dura mater*.

Prof. Keen (*Amer. Journ. Med. Sci.*, 1888) published a case of fibroma, weighing over three ounces, attached to the dura mater, which he removed successfully in a patient aged twenty-seven in 1887. The growth probably dated to an injury in childhood. It caused epilepsy, aphasia, complete hemiplegia, intense neuralgia, deafness, and great impairment of vision. After the operation, save for the eye and ear symptoms, all the others had passed away except slowness of speech and the epilepsy, and the last was much improved.

In the same periodical for 1896 (vol. cxii. p. 563), Prof. Keen gives the state of this patient nine years after the operation: "Eyesight still imperfect. Epileptiform attacks recur now at intervals of about a year. Patient still very nervous, and unable to do any work."

Sir W. MacEwen (*Lancet*, Aug. 11, 1888, p. 304) has published a case in which a growth of the dura mater caused irritative lesions of the left frontal lobe. The patient was restored to perfect health, and died eight years later of Bright's disease.

In the above mentioned cases the growth was limited to the dura. A detailed account of a case in which a growth originating in the dura involved the cortex of the brain is recorded by Dr. Bremer and Dr. Carson, of St. Louis (*Amer. Journ. Med. Sci.*, Feb., 1895). The growth was an endothelioma of the nature of a cylindroma, containing, as well, nearly all the varieties of sarcoma. Owing to the characteristic spread of the paralysis from one, the shoulder centre, to the others of the upper extremity, the diagnosis of growth of the brain was made, though headache, vertigo, nausea and optic neuritis were absent. At the operation alarming hæmorrhage took place during the removal of the growth.

to the immense size of some branches of the posterior meningeal vein. This was treated by packing while the opening was enlarged. The dura was dark, covered with large vessels, and presented no pulsation. It was adherent to a growth beneath, which, though friable, was easily lifted from its bed between the dura and the apparently healthy brain. The patient died on the twelfth day with pyrexia and delirium. The sites of the hypodermic injections made at the time of the operation had suppurated. At the necropsy a portion of the growth was found to have escaped removal, and the microscope showed that the surface of the brain was itself invaded.*

I take now *growths of the brain itself*. Some help as to the varieties of growth most likely to be met with will be gained from the following table (Dr. W. Hale White, *Guy's Hosp. Rep.*, 1886). The interval since the publication of this paper may make it appear out of date. Owing to the care with which it was drawn up, and the sound pathological basis on which it rests, this is not so. The paper remains one of great value and is still quoted and relied upon by different authorities. It will be noticed that Dr. W. Hale White's conclusion that 10 per cent. of the cerebral growths collected by him could certainly have been operated on is distinctly higher than is shown to be the case now in the light of the experience of twenty years later.

Of 100 cases of cerebral growth the proportions were as follows :

Tubercle	45
Glioma	24
Glio-sarcoma	2
Sarcoma	10
Carcinoma	5
Lymphoma	1
Myxoma	1
Cyst	4
Gumma	5
Doubtful	3
	100

Of the 45 cases of tubercle, the cerebrum was affected in 22, the cerebellum in 20 cases. The growth was multiple in 19, and single in 24 cases. In all the 45 cases one or more other structures than the brain were affected. Dr. W. Hale White concludes that not more than 3 tubercular cases were likely to be benefited by operation, and even in these the other organs were tubercular.

Of the 24 cases of glioma, of 10 only could it be said that they were not infiltrating. The cerebrum was the seat of the disease in 13 cases, the cerebellum in 4. In 1 case there were multiple gliomata in the brain, and in 2 others there were growths in other parts of the body.

Of the 10 cases of sarcomata several affected the dura mater in inaccessible positions; of the 5 cases which attacked the brain only, 1 alone could have been removed with any prospect of success. Of the remaining growths none of the carcinomata or glio-sarcomata were amenable to treatment. Of the 4 cases of cyst 1 could certainly, and

* The apparently healthy surface of the brain met with here at the time of the operation should be compared with the same misleading point in Mr. Ballance's case p. 361).

another possibly, have been operated upon; the myxoma was, and the lymphoma was not, amenable to operation; and of the 3 doubtful cases, 2 could have been operated upon. Dr. W. Hale White's summing up is as follows: "Thus we see that out of 100 cases of tumour of the brain, 10 might certainly have been operated upon, and 4 additional ones might possibly have been; so that in 10 per cent. of our cases we can hold out some hope of operative relief to our patients, provided that a correct diagnosis of the position of the growth be made, even so late as shortly before their death, whilst, of course, earlier in their histories many others might have been operated upon with a good prospect of success."

I will put side by side with these conclusions of Dr. W. Hale White those of another physician well known for his great clinical and pathological experience—Dr. Byrom Bramwell, himself an authority on this subject, the conclusions having been given at a debate on Intracranial Surgery, at the Medico-Chirurgical Society of Edinburgh (*Trans.*, vol. xiii. 1894, p. 180). Dr. Bramwell considered that the cases in which intracranial tumours can be successfully removed by the surgeon are rare, a consideration of the conditions present making it easy to understand why this must necessarily be the case. (1) In a certain but very small number of cases an intracranial tumour is not characterised by any symptoms during life which enable a positive diagnosis to be arrived at. (2) In some of the cases of intracranial tumour in which the symptoms—*e.g.*, headache, vomiting, giddiness, and double optic neuritis—distinctly show the presence of an intracranial tumour, there are no localising symptoms which enable the physician to determine in what part of the cranial cavity the tumour is situated. These cases constitute a not inconsiderable proportion of the whole. It is by no means uncommon to meet with large tumours in the temporo-sphenoidal and frontal* lobes, the "silent areas" of the brain, which are unattended

* There is increasing evidence to show that the frontal lobes can no longer be regarded as "silent areas" as has hitherto been the case. This is important, as it is a favourable region for operative interference, and owing to the above belief that lesions here show no especial symptoms and the consequent lack of careful investigation, growths have been allowed to attain a dangerous size before their removal has been attempted. Dr. Allen Starr concludes from a study of cases of growths of the frontal lobes: "The form of mental disturbance in lesions of the frontal lobe . . . is to be described as a loss of self-control and a subsequent change of character. . . . Thus we would expect the partial destruction of the frontal lobes to be accompanied by errors of judgment and reason of a striking character; one of the first manifestations would be a loss of that self-control which is a constant accompaniment of mental action, and which would be shown by an inability to fix the attention, to follow a continuous train of thought, or to conduct intellectual processes. It was this very symptom which was present in one-half of the cases. It did not occur in lesions of any other part of the brain." A recently published case (*Lancet*, April 29, 1905) by Captains McCay and Thurston (I.M.S.), Medical College Hospital, Calcutta, of a glio-sarcoma of the right caudate nucleus pressing on the frontal lobe bears out the above-quoted remarks of one of the first American neurologists. The chief reasons for localising the growth here as one affecting the frontal area were right frontal headache, tenderness in the same region—my readers will note that the lesion was not a cortical one—and the peculiar mental symptoms, *viz.*, loss of memory, apathy, loss of sense of shame, and loss of inhibitory power. The skull was opened over the area of tenderness, but nothing was found on incision and palpation of the dura. The necropsy three days later, showed the growth to be situated as stated above.

with any very definite and characteristic localising symptoms. The occipital lobe was formerly also thought to be a silent area, but it is now known that lesions in this situation produce homonymous hemianopsia, a most important localising symptom (p. 344). (3) In a few cases, in which there are localising symptoms, these give an erroneous impression as to the position of the tumour.

In support of this statement an instructive case is given in which, in a syphilitic patient, the local pain and tenderness and the localised character of the spasms, which commenced in the left big toe, clearly indicated that the tumour would in all probability be found in the cortex in the region of the foot-centre. The necropsy showed a glioma involving the right optic thalamus, the growth having encroached upon the posterior division of the internal capsule and apparently implicated the fibres to the left leg.

(4) In many of the cases in which the exact position of the tumour is clearly demonstrated, successful operative procedure is impossible or uncalled for. Thus, (a) in addition to tumours situated at the base, the basal ganglia, &c., Dr. Bramwell is inclined to include under this head a large proportion of tumours situated in the cerebellum, and for these reasons:—The surgeon can hardly hope to successfully remove tumours which involve the middle lobe of the cerebellum. Tumours which are situated in the lateral lobes are with difficulty reached, and the operation required for their removal is a dangerous one; the surgeon has to work in a very narrow space, and there is a risk of wounding the large venous sinuses, the medulla, the pons, &c. Further, it is often an extremely difficult or impossible thing to determine, during life, in which lateral lobe of the cerebellum the tumour is situated. (b) In many cases the tumour is so extensive and infiltrates such a large area of brain tissue that its complete removal is impossible. (c) In others the tumour is multiple. (d) In others it is malignant and of a secondary nature. (e) In some the cerebral tumour is complicated by associated lesions in other organs which contraindicate any operative interference. Thus, in not a few cases of tubercular growth of the cerebellum the lungs are also affected, and in some syphilitic cases the vessels either of the brain or other parts of the body are so extensively diseased that an operation is very hazardous. (f) Speaking of syphilitic growths, Dr. Bramwell, while admitting the good results obtained by very active drug treatment, was disposed to think that in many of the syphilitic cases in which the gumma is large and of some standing—cases in which a cicatrix must necessarily remain on the surface of the brain—operative procedure is advisable after the acute symptoms have subsided under the vigorous use of specific remedies, as the termination of many of these cases (the patients ultimately becoming useless members of society, or insane) is so deplorable.*

The above conclusions of Dr. Byrom Bramwell are based on an analysis of 82 cases of intracranial tumour which he had seen during life, and which he had examined post-mortem. In 77 out of the 82 operative interference was contraindicated. Of the 5 remaining cases

* While admitting the force of this opinion, I am afraid that if surgeons follow Dr. Bramwell's advice they will sometimes find, if they publish the results of their cases after carefully watching them, that they have merely substituted one cicatrix for another (p. 282).

he considered that in 2 the success of an operation would have been extremely doubtful; in the remaining 3 an operation might, he thought, have probably been attended with success.

But, while believing that there are comparatively few cases in which the surgeon can hope to successfully remove an intracranial growth, Dr. Byrom Bramwell would very strongly advocate trephining as a palliative measure* in many of these cases. "Thus, in not a few, the headache is intense, and it has been conclusively shown that in some of these cases sudden death takes place, apparently as a result of the pain and inhibition of the heart, a point to which Dr. Hughlings Jackson has directed attention. Again, in other cases in which the intracranial pressure is greatly increased, the patient dies either suddenly in an epileptic fit, or gradually as the result of failure of the respiration. Further, it must be remembered that in a large proportion of the cases of intracranial tumour the optic neuritis is intense, and that in not a few of them the optic neuritis, if allowed to continue, passes on to optic atrophy, and produces more or less, and it may be complete, blindness. Now, it has been conclusively shown that in some cases in which the operation of trephining has been performed both for tumour and abscess, the optic neuritis has speedily disappeared, in consequence, I believe, of the sudden relief of the increased intracranial pressure."

I have given the opinions of two well-known physicians in this country on the percentage of cerebral growths suitable for operation. To turn elsewhere, Oppenheim analysed 23 cases observed by himself and verified by necropsy. Only 1 could have been removed by operation. V. Bergmann puts the percentage of suitable cases as at most at 6 to 7 per cent., and, with very few exceptions, would limit the operation at present to growths of the motor region and to those parts of the brain adjoining it.

Having spoken in general terms of intracranial growths, I now propose to consider, from a surgeon's point of view, the varieties most frequently calling for operation. These are the Tubercular, the Gliomata and Sarcomata, Gummata, and Cysts.

Tubercular Growths.—As a rule these should only be attacked when there is good reason to believe that the growths are primary and single. The frequency with which they are multiple† and present as well elsewhere is alluded to above (p. 353). But where a tubercular growth is threatening to cause blindness, severe headache, constant vomiting, &c., it should be explored, and removed if possible. Sir V. Horsley (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365) expressed himself as strongly in favour of operation. Where a trial of medical treatment for four months fails, such tubercular nodules are probably densely fibrous with caseated centres. Age, no doubt, has an important effect here. Thus, in a child, owing to the yielding skull, the presence of a tuberculous mass may be long unsuspected or ill-marked.

Ransohoff, of Cincinnati, whose personal experience is considerable, as he has operated on 8 cases of cerebral growths, reports his two successes with very instructive comments (*Journ. Amer. Med. Ass.*,

* Palliative measures are again referred to at p. 364.

† Lumbar puncture (*q.v.*) may help in deciding whether a tubercular meningitis co-exists.

Oct. 11, 1902). The nature of the growth in the first case is not stated. The second case, stated to have been a solitary tubercular deposit, was operated on in two stages.

At the first operation an opening $3\frac{1}{2}$ inches long and 3 inches wide was made. When, three days later, the dura, which pulsated feebly, was opened, no growth was found. The patient was now placed in the sitting position—local anæsthesia was being now employed—a step which caused the brain to recede and allow of palpation far beyond the limits of the cranial opening. The growth was found half an inch below the surface in the ascending frontal convolution, and was easily removed. Three and a half months after the operation the patient had had no convulsions, but a decided weakness of the flexors of the thumb, index and middle fingers remained. In this case the general symptoms of brain growths (headache, choked discs, and optic neuritis) were absent, the symptoms being altogether focal. This is explained by the fact that when the growth was removed it displaced 12 grammes of water, a pressure to which the brain accommodates itself. With the development of symptoms of intracranial pressure the value of focal symptoms decreases. This explains the frequency of failure to find a growth when seemingly unmistakable localising symptoms are present. Against 107 collected cases in which operations were successful in finding and removing a growth, there are 157 in which the operation was unsuccessful in one or the other respect.

Ransohoff points out that in two-stage operations the second one can be done satisfactorily under local anæsthesia. If it be needful to cut away more bone, chloroform must be administered. He thinks that adoption of the two-stage method will diminish the very high mortality. This, due chiefly to shock and hæmorrhage, is stated by Haas, from an examination of 122 operations for removal of growths, to be as high as 61 per cent. Ransohoff believes that tubercular deposits in the brain are twice as common as any other growths.

He quotes from a paper by Preyer, who (*Rev. Méd. de la Suisse*, May and June, 1900) collected the cases operated on up to that time, sixteen in number; Ransohoff's case and one of Heidenhain made eighteen. Three died from the operation; six survived several months, two several years; one of Czerny's lived four years and two months, one of Sir V. Horsley's seven years and eight months, dying then of tubercular disease of the spine; one operated on by Kronlein is believed to be alive, six years after operation.

V. Bergmann some years ago opposed operations on tubercular deposits in the brain on the grounds, chiefly, of the risk of setting up tubercular meningitis and the great difficulties of enucleating such a deposit here, compared with one in the skin or bones. In his recently published "Surgery" (*Amer. Tr.*, vol. i. p. 322) he declines to enter into the question as to whether operation for tubercle, especially in the cerebellum, should be undertaken. He "has reported twelve cases of cerebral tuberculosis treated operatively. In seven of these the central convolutions were affected; in four the cerebellum. In one in addition to disseminated tuberculosis of the pia, there was an affection of the parietal lobe. Of the seven cases with affection of the motor region three were cured, two died from the effects of the operation, and two from an extension of the tuberculosis. The five cases of affection of the cerebellum all terminated fatally, three immediately after the operation. In eight cases the tubercles were not completely removed, and in each case death rapidly ensued."

Casating foci in the cerebellum, owing to their comparative frequency, need especial allusion. The very high mortality of which v. Bergmann's results—himself one of the chief authorities on cerebral surgery—and the cases alluded to below make it extremely doubtful if it is justifiable to continue attacks on tubercular deposits here (p. 380).

Sir V. Horsley (*Brit. Med. Journ.*, April, 1887) has removed a tubercular growth from the right lobe of the cerebellum.

Death took place nineteen hours later, the patient having only partially recovered consciousness. Generalised chronic tubercle was found in the viscera. The operation was here performed as a *dernier resort*.

Mr. Bennett May (*Lancet*, April 16, 1887) removed a similar growth from the right lobe of the cerebellum of a child.

The extreme bulging of the dura mater gave evidence of great intracranial pressure. The cortex appeared quite healthy, but at one spot palpation gave an ill-defined feeling of hardness. This spot being incised, the finger detected a hard mass nearly an inch below the surface. This was dug out with the handle of a small teaspoon. It was larger than a pigeon's egg, hard and horny outside and caseating in the centre. The hæmorrhage was trifling, but the patient sank from shock a few hours later. No necropsy was permitted.

Mr. Waterhouse (*Brit. Med. Journ.*, Oct. 1, 1898, p. 968) mentions with helpful candour three cases in which he had operated upon tuberculous growths of the brain. In none was the tumour single. Two cases died within forty-eight hours of the operation, while in the third partial recovery for four months ensued, followed by death, due to another tubercular growth.

These fatal cases of operation on cerebellar growths afford me the opportunity of reminding my readers that the mortality after operation on parts of the cerebellum is higher than that for cerebral growths. This fact is dealt with below in the Section on Operations on the Brain, p. 380.

Gliomata and Sarcomata.—As several cases are referred to, some fully, in these pages, viz., the cases operated on by Mr. Godlee (p. 346), Mr. Ballance (p. 349), Dr. Weir (p. 351), and as the important questions of appearance and infiltration are dealt with in the section on Operations on the Brain (p. 379), I shall only refer to one more instance of these growths. It will be found reported by Dr. C. K. Mills (*Phila. Med. Journ.*, Sept. 27, 1902); the following epitome is given in the *Brit. Med. Journ.*, Jan. 24, 1903, p. 13. It contains two especial points of interest: (1) the use, successfully, of the Röntgen rays as a means of diagnosis, and (2) the means adapted for meeting the hæmorrhage. The case is stated to be the third—including one published by Dr. Mills in February, 1902—in which the Röntgen rays have been of definite service in the localisation of a cerebral growth.

The patient, a girl, æt. 21, had had symptoms for three years, and presented all the classical phenomena—optic neuritis, headache, vomiting, &c., together with left hemiparesis. Skiagraphy showed an abnormal shadow of about 3 inches in diameter, and irregular in outline, lying directly upon the Rolandic area. Over its anterior portion the middle meningeal and its branches ran, and the inner table of the skull was seen to be disorganised over the region of the growth. The central fissure having been localised, the cranium was opened by Stellwagen's trephine (Fig. 140, p. 376), but the hæmorrhage was so severe that the wound had to be packed and further steps postponed. The patient rallied well, and at the second operation, owing to the severe hæmorrhage before, both common carotids were clamped by Crile's method.* An encapsuled ovoid growth, 3 inches in length, which proved to be a spindle-cell sarcoma, was discovered and removed with hardly any bleeding. The patient died in a few hours from post-operative shock.

* This is described, together with other methods of temporary closure of the common carotids, *q.v.*

Gummata.—Some have expressed the opinion that here surgical interference is uncalled for. While no one will operate on a gumma of the brain till a sufficient trial has been given to mercury and potassium iodide,* there is no doubt whatever that a syphilitic lesion may reach a stage here, *e.g.*, from its density, as elsewhere, in which it has quite got beyond the reach of specific remedies. Such a lesion, if localisable and to be got at, should be attacked, because, if left alone, it will go on causing trouble indefinitely, and further, the compression and wasting of adjacent nerve tissue which it will set up will in time become irreparable. On this point the remarks of Dr. Byrom Bramwell (p. 355), bear strongly.

Sir V. Horsley, who is of opinion (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365) that cerebral gummata are not really cured by drugs, would certainly limit the trial of drugs to two months. He holds that gummata are here incurable, because there is always a certain degree of pachymeningitis around them, and that this is inevitably progressive.

One of the most interesting instances of operation in these cases is one of Sir W. Macewen's (*Lancet*, May 23, 1885).

In a woman, aged 25, there was left-sided motor monoplegia of arm and leg, preceded by muscular twitchings and tingling sensations, without loss of sensation, due to syphilis, which resisted prolonged treatment. A cortical lesion of the right motor area, in the upper half of the ascending frontal and parietal convolutions, with probable involvement of the paracentral lobule, was diagnosed. A crown of bone over an inch in diameter, with its anterior border reaching to a point about half an inch behind the auriculo-bregmatic line, and its upper margin reaching to within half an inch from the centre of the superior longitudinal sinus, was removed. Its inner surface showed osteophytes. The dura mater was thickened and rough. Crucial flaps of this being reflected, a yellowish opaque effusion covered the brain, obscuring the convolutions and bridging the fissure of Rolando. This was very friable and came away in minute portions. Towards the upper part of the opening the brain offered resistance on palpation. This sensation proceeded from the interior of the brain, in the direction of the paracentral lobule, a layer of brain tissue intervening between this more resistant structure and the finger. An incision being made through the upper part of the ascending parietal towards this firm structure, about two drachms of gummy fluid escaped. The resistance now disappeared, and cerebral pulsation was now, for the first time, feebly perceptible. The patient made a good recovery, and regained sufficient power over the left side to enable her to walk two miles, and to do her household work.

Mr. Waterhouse (*loc. supra cit.*) mentioned an interesting case of intracranial gumma, in which, in spite of the administration of potassium iodide and mercury for four weeks, and then potassium iodide in doses of 30 gr. t.d. for a further period of five weeks, the symptoms steadily increased. The patient became hemiplegic, then comatose. A large gumma was removed "from the left area of Rolando." Recovery was rapid and complete.

A recent case of gumma and localised meningitis of the motor region

* The American method of pushing this drug in large doses at frequent intervals, in milk (*Arch. of Medicine*, New York, Oct., 1884), is especially applicable here. A warning is needed now. Whether this drug be used for gummata or in uncertain cases, its lowering effects must always be remembered. In my opinion, some days should always be allowed to elapse between the discontinuing of the drug and the operation, otherwise the shock of a severe operation will be needlessly increased.

successfully operated upon will be found reported by Dr. C. K. Mills, (*Phila. Med. Journ.*, Nov. 29, 1902).

The patient, æt. 27, had been twice previously treated with success by large doses of potassium iodide. On his third admission the prominent symptoms were extreme pain in the left parietal region, frequent spasmodic seizures of right upper and, later, of right lower limb and right side of face. When the bone-flap was turned back—Dr. Hearn used Stellwagen's trephine (p. 376)—the dura was adherent to the skull over a considerable portion of the bone-flap which had to be pulled away from the membrane. The latter was, in places, four or five times thicker than normal. The dura, pia and arachnoid were adherent to each other and to an oblong flat mass, which corresponded almost exactly in its dimensions to the shadow furnished by the Röntgen rays. As it was impossible to dissect the membranes from the mass beneath, it was decided to remove them together. This was done with but little disturbance of the brain tissue. To replace the removed dura, advantage was taken of a suggestion by Prof. Keen, and an incision made in the scalp outside of the line of the main opening. The scalp was turned back, and a piece of the pericranium dissected loose, and inserted into the opening left by removal of the dura. This piece of pericranium was turned upside down, so that the osteogenetic surface would be away from the brain, and not next to it. The last note of this case, four weeks after the operation, runs as follows:—"The patient had made a perfect surgical recovery; his headache and epilepsy have disappeared."

Cysts.—There are three separate conditions under which these growths especially occur. (i.) One is in the cerebellum, particularly in childhood, and affords the only hopeful outlook for operations here. Dr. Goodhart's words (*Diseases of Children*, p. 440), are to be remembered. Simple Cysts, "although not common, may be kept well in memory. I must have seen some five or six cases, and one can never see a fatal ending in such as these without regretting that surgery was not allowed to attempt to cure." (ii.) Cysts may also occur after injury over the motor area, as in the two following cases (Macewen, *Brit. Med. Journ.*, Aug. 11, 1890):

Epilepsy (Jacksonian) induced by a Focal Facio-lingual Lesion—Removal of Cyst from Brain—Cure.

A man, aged 22, had epileptiform convulsions, each lasting from two to three minutes with an average of over 100 in twenty-four hours. The convulsions were limited to the tongue, right facial muscles, and platysma. When they subsided the parts remained paralysed. Consciousness was retained. Eight years previously he received an injury to the head, after which his right arm became weak, though he was able to work. It was clear that an irritating focal lesion existed, confined to the base of the ascending convolutions, causing a Jacksonian epilepsy. At the operation, in the lower part of the ascending frontal a cyst about the size of a filbert was found, situated partly in the cortical and partly in the white substance of the brain, surrounded by a narrow zone of encephalitis. In manipulating the medullary substance during the removal of the cyst, the patient, while under chloroform, had a convulsion similar to those prior to the operation. The convulsion ceased with the removal of the cyst, and he never had another. The wound healed firmly under one dressing, the paralysis of the facial muscles soon disappeared, and the patient has since been constantly at work. The power of the right arm has also increased. Possibly the cyst might have caused, indirectly, slight pressure on, or had set up inhibitory action of, the middle part of the ascending frontal.

In another case, in which brachio-crural monoplegia was present, with late rigidity, these dating to an injury eight months before, Sir W. Macewen removed a large, thick-walled, subdural cyst, containing clear fluid, which was pressing on the motor convolutions, together with a spicule from the inner table, which had penetrated the brain. The paralysis, with the contraction of the muscles, passed off to a great extent. The patient could neither walk nor stand before the operation; afterwards he could run about, and use his hand well, though there was still paresis in both limbs.

I have already (p. 279) alluded to the difficulty which is sometimes met with in securing the obliteration of these cysts, and the need, here, of frequently prolonged drainage. (iii.) While the two forms of cysts mentioned above are those most frequently met with, the surgeon must be prepared to meet with a third in which the cyst is associated with a new growth. The best reported of these with which I am familiar is that of Mr. Ballance (*Trans. Med. Chir. Soc.*, Mar., 1896).

A boy, æt. 11, had, six months before admission, received a severe blow on the head. Fits, commencing with twitching of the right angle of the mouth, were followed by paralysis of the right side of the face, and right extremities. Nov., 1890.—The left lower motor cortex having been exposed, a large subcortical cyst, lying under apparently normal brain tissue, was found and evacuated. Feb., 1891.—As the symptoms returned, a tube was passed into the cyst, in order to drain it continuously. The symptoms then in most part disappeared, and the boy remained in fairly good health until Jan., 1893, when his condition rather suddenly became exceedingly grave. At a third operation a growth three ounces in weight was removed from between the dura and the left motor cortex. The boy left the hospital quite well save for a slight right hemiplegia, June, 1893. He was re-admitted in Sept., 1893, in an almost moribund condition, and died a few hours after another attempt to relieve the symptoms of pressure. At the necropsy an enormous growth was found in the left cerebral hemisphere.

Mr. Ballance, with his accustomed fulness and mastery of the subjects, discusses the intermission of symptoms, the diagnosis, relations to injury and several other points.

If I am right in saying that cerebral surgery has not done as much as was expected of it ten years ago, and that surgeons no longer attack cerebral growths with the enthusiasm and frequency of the same date, this proves that the enthusiasm was not based on careful and reliable reasoning, that operations for cerebral growths were performed without sufficient discrimination, and that the risks inseparable from this path in surgery were under-estimated—surgeons forgetting that while aseptic surgery had removed certain risks, others remained inseparable from the peculiar vitality of the part attacked. I refer especially to shock and collapse. I think that any candid surgeon, acquainted with the history and progress of his profession, will allow that in three directions the progress of modern surgery has been less brilliant than might have been expected when its other triumphs are considered. The three referred to are: removal of cerebral growths compared with the other advances of cranial surgery, the surgery of the intra-thoracic viscera, and the operative relief for acute intestinal obstruction compared with the brilliant successes in other branches of abdominal surgery. The explanation of this is not far to seek. I maintain it lies in the fact, to which due weight has not been attached, that all the organs here concerned are peculiarly vital structures, and that, however great advances may be made, this fact will remain unchanged.

That the above remarks are fair and just will, I think, be allowed by anyone who refers to the last discussion on the Treatment of Intra-cranial Tumours, introduced by Dr. Ferrier in a speech of great ability (*Brit. Med. Journ.*, Oct. 1, 1898), in which he put the question of operation in the most favourable light possible. Dr. Ferrier mentioned, briefly, two cases in which the patients had survived the operation two years or more. Two surgeons only took part in the discussion, and two more successful cases of removal of cerebral growths were mentioned, but so briefly as to be of very little value. Dr. Byrom

Bramwell, the president of the section before which the paper was read, stated that his "experience in regard to the success of operative procedure differed notably from that of Prof. Ferrier, for in none of his fourteen cases in which an operation had been performed had a tumour been successfully removed by the surgeon. The additional experience of the past few years had entirely confirmed the conclusions which he had published in the *Edinburgh Medical Journal* four years ago."

Speaking of the proportion of operable cerebral tumours, Dr. Ferrier considered it a fair estimate to say that only 7 per cent. of cerebral tumours are capable of being surgically dealt with. As to the recent statistics of the results of operation, he considered that when cases were collected from all sources, and therefore containing many factors not strictly comparable with each other—of which one, the personal equation of the operator, is exceedingly variable,—such a collection of cases gave 13 per cent. of complete* recoveries, i.e., the patients were alive at least a year, and in some cases several years, after the operation. Turning to the cases at the National Hospital for the Paralysed and Epileptic, where the operations were performed by Sir V. Horsley and Mr. Ballance, men of special skill in this branch of surgery, Dr. Ferrier pointed out that the cases operated on gave a percentage 16.6 of complete recovery.

Two well-known authorities on growths of the brain, Dr. Beevor and Mr. Ballance, thus reply to the question, "What do patients suffering from tumours of the brain gain from surgery?" (*Brit. Med. Journ.*, vol. i. 1895, p. 8. My readers will find the case on which this paper is based quoted from at p. 349):—

"It appears to us that in the several following ways enormous benefit may be given by operation: 1. The complete removal of a tumour, as in Sir V. Horsley's case, of a small tubercular mass occupying the cortex in the region of the representation of the movements of the thumb.

"This patient, a man, æt. 20, suffered from frequent local fits, beginning in the thumb and forefinger, and from headache. From these symptoms he was completely relieved by the removal of the tumour and part of the cortex.—*Brit. Med. Journ.*, 1887.

"2. Partial removal of a tumour, as was probably done in the case on which this paper is founded.

"The operation on this patient relieved her of headache, vomiting, double optic neuritis, and from the greater part of her paralysis. The mental condition, which was very much deteriorated, was restored, the patient regaining her former cheerful condition.

"3. The drainage of a cavity in a cerebral glioma or sarcoma which cannot be removed. This is well illustrated by a case under the care of Sir W. Gowers and Mr. Ballance.

"The patient, aged 11, suffered from headache, vomiting, double optic neuritis, fits beginning in the thumb and followed by hemiplegia, and was practically relieved of all his symptoms, including moral deterioration (stealing), by this procedure. He lived for three years.

* The correctness and value of this word "complete" will be estimated by my readers according to their experience and the number of years which they consider must elapse after an operation for malignant disease, before the patient can be stated to be "completely" cured.

"4. The removal of bone and incision of the dura mater. The benefit resulting from this operation is well shown by a case which was under the care of Dr. Buzzard and Mr. Ballance.

"A woman, aged 41, was admitted with symptoms pointing to tumour of the internal capsule, namely, hemianæsthesia, nearly complete hemiplegia, double optic neuritis with failing sight, and severe headache with agonising paroxysms. In one of these paroxysms she became comatose, and was evidently dying, it was thought from hæmorrhage into the tumour. The above operation was at once performed, and the relief of the urgent symptoms was immediate; and in a month's time the report states that there was no headache, vomiting, or optic neuritis, and some return of power and sensation had already occurred, with improvement of sight and restored mental condition.

"5. Removal of a considerable area of bone without opening the dura mater is, we believe, considered by some to be adequate to relieve the classical symptoms of tumour. It is true that the dura bulging through the opening in the skull indicates that there is a relief of pressure, but what we have to deal with is tension within a practically inelastic membrane, and the intra-dural space can hardly be materially increased while the dura is intact, and the opening in the skull is comparatively small. The sac of the dura cannot be distended to its full extent while the cranium is intact, and so when bone is removed its foldings are flattened out. A considerable fall in pressure can only be obtained by taking away a large area of bone, and in tumour cases when this is done the dura still bulges under much *plus* pressure. As we have known of no case in which the removal of bone alone has relieved the pressure symptoms, we should advise that the dura should always be opened; another reason of great import being that the cortex might be involved without any of the type signs being present. . . .

"6. We would conclude this paper with the question, How soon should one of the preceding operations be performed? When the type symptoms are present, it is quite certain that no delay is desirable after a fair trial has been given to antisyphilitic remedies, and we should limit this time to six weeks or two months (Sir V. Horsley, *Brit. Med. Journ.*, 1893). The main difficulty arises when the symptoms are not typical; and it is to be borne in mind that large slowly-growing tumours may be present without any symptoms which are unequivocal. As an instance of this a case may be referred to which was under the care of Sir V. Horsley and Dr. Beevor. The patient had occasional fits with unconsciousness, beginning in the corner of the mouth, six years before other symptoms arose which justified operation, and then the tumour was found to be so situated that it could not be removed without producing aphasia. It would be easy to mention other cases illustrating the same point. In any case where the typical signs of tumour are absent, and where the fits always begin with the same localised warning, and are attended with loss of consciousness, the question is, Are these fits due to idiopathic epilepsy, or are they due to a tumour? And we should say that no operation is advisable, other signs of tumour being absent, unless the paralysis which follows the fits is permanent—that is, not recovered from in the course of a few days—or unless the fits occur very frequently. While it is impossible to lay down absolute rules for the treatment of these cases, it would appear that occasional fits, beginning locally, followed by loss of consciousness,

and attended only by headache, would not justify an operation; but that any other combination of the type symptoms—headache, purposeless vomiting, optic neuritis, especially with failing sight, localised fits, and permanent paralysis—would render surgical operation advisable."

We come now to the last of the questions which arise before an operation on a growth of the brain: (F) *The conditions which justify operative interference, and the probable results of this step.* I consider that anyone who has taken the trouble to make himself acquainted with a large number of operations on growths of the brain will agree with me that the following are based upon fact, and that they are free from unjustifiable pessimism.

(1) That as the most benign growths have proved ultimately fatal, operations are justifiable under certain conditions. But (2) the site of the growth should be known. At present, if localisation be impossible, no operation should be performed. The cases collected for v. Bergmann show this clearly. In one group, 116 cases, an accurate diagnosis was possible; in all the growth was removed, and in only 7 per cent. was the operation fatal. In the second group, 257 cases, the diagnosis was imperfect, and 50 per cent. died as a direct result of the operation. How far the Röntgen rays will help, we do not know as yet. At present growths of the motor area are the ones which most clearly justify attacks. Operations on growths of the cerebellum, excepting in the case of cysts, are not justified (pp. 355 and 380). (3) The growths which are most favourable for operation are fibromata, encapsuled sarcomata, and gummata. (4) The operation should be undertaken at an earlier stage than has hitherto been the case, before the patient is weakened by headache, vomiting, a long course of potassium-iodide, &c. (5) As a large opening in the skull is absolutely necessary, the operation should usually be performed in two stages. (6) Palliative trephinations have already been shown to be thoroughly justified (pp. 356 and 363). This step, if not deferred till too late, may be trusted to remove for a time the headache and vomiting, to arrest the optic neuritis which will go on to blindness, and to diminish, but probably not to arrest entirely the epileptiform convulsions. The following cases show that where a growth has been localised, but it has not been found, and where its complete removal has not been possible, the symptoms have been materially relieved by the relief given to the pressure. Thus in the *Lancet* of April 7, 1888, a case under the care of Mr. F. A. Heath is reported, in which, though the tumour was not removed, owing to adhesions to the anterior fossa, the benefit derived from the relief given to the pressure was most decided.

The patient recovered promptly from the operation, with the formation of a hernia under the healed scalp, shortly after regaining considerable power of motion in the paretic limbs, remaining free from epileptic attacks for over two months, and for a long time being rid of his headache. He was seen thirteen months after the operation, and, though completely blind, could walk about very well. Of late, the headache had returned and the epileptic attacks had become more frequent.

The following case of Fischer's, of Breslau (*Centr. f. Chir.*, Bd. xxix. 1889), bears on the same point.

A patient was admitted with complete paralysis of the right arm, which had been coming on for a year, and very severe headache on the left side. The right leg was also weaker, dragging a little in walking. The left pre-central convolution was exposed, but

no trace of a tumour could be found. The patient experienced great relief from the operation. The headache was gone, the arm paralysis was less, and the convulsions ceased. Five months later the patient began to complain again, the paralysis of the right arm and leg having increased, and epileptiform seizures being of daily occurrence. He urged repetition of the operation. The skull being again opened at the same place, a red lobulated tumour soon bulged up. It was shelled out piecemeal with the finger, as it continually broke off on pulling, severe hæmorrhage resulting. The growth was also firmly adherent to the dura. The hole in the brain was lightly plugged with iodoform gauze. All symptoms of growth were again in abeyance. Two months later the patient began to complain again, and now a growth grew through the trephine opening. The autopsy showed that the growth of the brain had been completely removed. The recurrence started from the dura. It was a vascular round-celled sarcoma.

Similar relief is well shown by a case brought before the Clinical Society by Mr. Pearce Gould (*Trans.*, vol. xxxi. p. 286). The patient, æt. 41, had, six weeks before, suffered from severe headache without vomiting, followed by aphasia, right facial paralysis, and stupor deepening into coma (Feb. 7, 1897). A two-inch trephine was used over the left face-centre. When the dura mater, which bulged into the wound without pulsation, was divided, the brain bulged still more. Puncture of this with a director in two or three directions proved negative. Four days after the operation the brain had receded below the trephine opening over which the scalp had been replaced; three days later the patient was quite conscious and had lost his headache, paralysis, twitchings, and aphasia. He was able to resume work in four months, but it was noted that six epileptiform fits had occurred; otherwise the health was good. Mr. Pearce Gould informs me (June, 1905) that this patient was able to earn his living as a market-gardener. He was, however, still liable to epileptic attacks—about one a week—and during one of these he was drowned in 1903. Permission for a necropsy was refused. My readers will note that, in this case, in addition to the trephining, the dura mater was opened. On the advisability of this step the authoritative opinion of Dr. Beevor and Mr. Ballance should be referred to (p. 363).

Dr. Ferrier advised, if no guide to the site of the trephining, *e.g.*, pain on deep pressure, &c., be present, that the palliative opening be made freely over the occipital or frontal region. A free opening may lead to a hernia cerebri; this must be treated by careful pressure with a leaden plate, and the strictest asepsis: of the other palliative measures, drainage of the lateral ventricles and lumbar puncture, it must suffice to say that our knowledge is, at present, scanty, and that they are much less promising.

As to the actual *results*, even in the cases where the growth has been successfully removed, complete recovery is the exception. The life of the patient is saved, and the pressure symptoms, headache, &c., are cured, but the epileptiform seizures are only diminished, though often markedly so. Much the same may be said of the paralysis in many cases. It is not safe to make use of faradisation here, as this step may evoke afresh the epilepsy.

OPERATIVE PROCEDURES ON THE BRAIN, CHIEFLY FOR THE REMOVAL OF GROWTHS.*

Preparation of the Patient.—The day before the operation the patient's head is shaved, cleansed with soft soap, and then by ether or turpentine.

* Many other operations on the brain—*e.g.*, for abscess, removal of bullets—have been already fully considered. Several instances of removal of growths have also been given in the preceding pages. Sir V. Horsley (*Brit. Med. Journ.*, Oct. 9, 1886, and A 7) first insisted on the majority of the details above given.

It is then soaked for three minutes with a solution of biniodide of mercury in methylated spirit (1 in 500). This is washed away with a watery solution of biniodide (1 in 2000), and an antiseptic dressing applied. Finally, the patient has the usual purgative administered the evening before, followed by an enema on the morning of the operation. Any course of iodides or bromides should be suspended for at least a week before the operation (footnote, p. 359).

Marking out the position of the lesion and the flap.—Great attention must be paid to the exact localisation here, and this step must not be left until just before the operation. Dr. C. K. Mills, a well known American neurologist, whose papers are always practical and lucid, emphasises the following from an experience of 22 cases in which operations were performed for new growths. "A mistake of less than one inch in locating the central fissure, or the height of the horizontal branch of the Sylvian fissure may add considerably to the uncertainties and difficulties in an attempt at removal by making the opening so as only partially to include the neoplasm. Not only the limits but as nearly as possible the direction of the osteoplastic flap should be marked out, as well as the extent and direction of its base-line, so that no loss of five or ten minutes takes place in attempts to localise it with chances that not even then is it in the best position or direction." The method of procedure of Dr. Mills, when it is intended to remove a growth, limited to the motor area, is as follows: "The central fissure and horizontal branch of the Sylvian fissure should first be indicated on the shaven scalp, then the area supposed to include the underlying tumour should be exactly mapped out, and, finally, the base-line of the flap which the surgeon is to make should also be indicated. The squamosal line which corresponds fairly well to the Sylvian fissure, and the line of the central fissure having been determined by the Anderson-Makins method (p. 339), the spot for the insertion of the pin of the Stellwagen trephine* is next determined. As the arm of this trephine can be extended so as to give a radius of nearly two inches, the point selected for the pin should be about half an inch in front of the central fissure, at about its middle or a very little below this point. It is now generally believed that the motor region is largely in front of the central fissure, and the circle outlined by the arm of the trephine, when the pin is placed in the position just stated, would be such as to include a little more than the motor region forwards and backwards, while it would nearly uncover it towards the median line and also in the direction of the Sylvian fissure. The Anderson-Makins lines and the circle can readily be marked on the scalp with a tape-line, compasses, and an aniline pencil. The base-line should be about $1\frac{1}{2}$ inches in length and should so bisect the lower portion of the circle as to cross the line of the central fissure at its lower extremity and at right angles to it. When the position for the pin and the extremities of the base-line have been determined by careful measurement, they are marked on the scalp by small incisions.† At the time of operation it is then only necessary for

* Page 376, Fig. 140.

† Or by nitrate of silver. A solution of silver nitrate (30 grs. to the ounce) is painted along the lines and allowed to dry. It is then brushed over lightly with a solution of pyrogalllic acid (5 grs. to the ounce). The silver stain thus produced is not washed away

the pin to be inserted in the proper position in the scalp, and for the knife to be inserted at one end of the base-line and swept around the circle until it reaches the other end. No time is then lost in determining the direction and length of this line. The aniline markings can of course be renewed when these positions have been determined, as will be necessary in order to complete the sterilisation of the scalp before operation."

Additional accuracy will be given by marking out the above lines and the supposed site of the growth with a fine drill or bradawl driven into the skull through the scalp, when the patient is under the anæsthetic.

Anæsthetic.—If not contraindicated, a hypodermic injection of a quarter of a grain of morphine* is given, and then chloroform is administered. The object of giving the morphine is twofold: in the first place, it allows of the performance of a prolonged operation without the necessity of giving a large amount of chloroform, the amount actually used in an operation lasting two hours being very small.

The second reason is perhaps the more important: that this drug causes well-marked contraction of the arterioles of the central nervous system, and that consequently an incision into the brain is accompanied by very little oozing if the patient be under its influence. Sir V. Horsley has not used ether in men, fearing that it would produce cerebral excitement; chloroform, on the contrary, producing well-marked depression. But if much tendency to shock existed, or if it were needful to keep the head raised, the above theoretical considerations would be disregarded in favour of the safer anæsthetic,† or the A.C.E. mixture. Local anæsthesia is referred to at pp. 357, 376.

Removal of the Skull.—In the following remarks I wish it to be understood that I am writing for the benefit of my juniors only, men who have necessarily had but little especial experience, not for the so-called specialist in brain surgery. I also take it for granted that for the present, at all events, operations for removal of growths of the brain will often be performed in two stages. Sir V. Horsley, to whom as a pioneer at once most skilful and scientific we owe so much, having turned down the flap which bears his name and which obviated the risk of a hernia cerebri inseparable from the old crucial incision, removed the necessary

when the scalp is subsequently purified, as is the case with aniline marks (Watson Cheyne, C. B., and Burghard, *Man. of Surg. Treat.*, Pt. v. p. 90).

* In one case, a child of 4, one-twentieth of a grain was found amply sufficient. The advisability of a preliminary injection of morphia has been a good deal disputed. Dr. F. W. Hewitt, in his most careful work on Anæsthetics, p. 274, thus puts the matter succinctly: "In feeble or exhausted patients, in those who are lethargic or semicomatose, and in those with any respiratory difficulty, I am convinced that the advantages obtainable from morphine are not sufficiently weighty to counterbalance the risks attendant upon its employment." When morphine is contraindicated, *sj.-sij* of the liquid extract of ergot may be given half an hour before the operation, as advised by Prof. Keen.

† Attention is also called to the startling rapidity with which a patient who has roused up in the middle of one of these prolonged operations, can be sent off again in a moment, with only a few whiffs of the drug, and that thus it is very easy to give too much in a brief space of time. Sir V. Horsley expresses a strong opinion that this sensitiveness to the action of the anæsthetic is more marked when the dura mater is opened.



FIG. 131.

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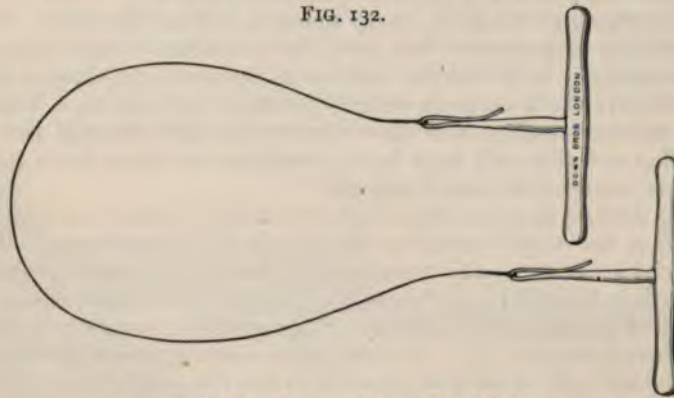
Powerful bone-forceps, used by Sir V. Horsley in the division of the skull. They are made by Hawksley.

amount of bone by a large trephine followed by the use of powerful bone-forceps or saw.

As long ago as 1889 Wagner introduced his *osteoplastic method of resection of the skull*, which, considered by many to mark very important progress, has increasingly gained ground in recent years. Prof. Krönlein thus strongly advocates its use (v. Bergmann's *Syst. of Pract. Surgery, Amer. Tr.*, vol. i. p. 330.) "The old opinion still holds that the power of regeneration in the convex bones of the skull following loss of substance is small, and that consequently defects of any extent are only filled with connective tissue, and not with bone. In certain cases such defects have recently been observed to close through regeneration of bone. These are, however, conspicuous exceptions, and as such they only confirm the rule. Experience shows that the connective tissue scar, which usually closes small defects of the cranial bones, may be so firm and dense as to lead one to believe that a production of new bone has taken place. The conditions are entirely different in case of more extensive defects of the skull which are only covered by skin and scar tissue. Such patients are considered not only extraordinarily vulnerable as regards any violence affecting the skull, but their infirmity frequently manifests itself in an entirely different manner. This is very clearly shown by an observation recently communicated by König. König's patient had an extensive traumatic defect in the left parietal region. He manifested a degree of weak-mindedness bordering on idiocy, and suffered from epileptiform attacks. All these severe disturbances, which König very correctly, no doubt, referred to the displacement and distortion at the surface of the brain in the region of the defect, disappeared as soon as König successfully brought about bony closure of the defect. Based upon such experiences it is altogether justifiable to demand that extensive and permanent defects of bones should be avoided from the beginning in cases of operations upon the brain." I should not myself attach so much importance as Prof. Krönlein to a single case, and it is by no means certain that where a large amount of bone has been removed and the healing of the wound has run an aseptic and

rapid course that the defect left and the resulting scar are of the weak and perilous nature implied by Prof. Krönlein. Anyone of large hospital experience is familiar with cases where after a comminuted compound fracture of the skull, the patient comes from time to time with a thinly covered pulsating scar, for renewal of a celluloid or more homely covering. But owing to the widely different conditions under which the two scars

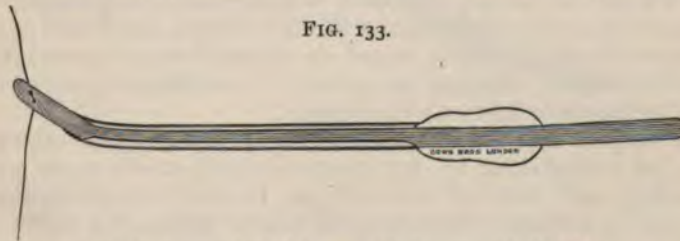
FIG. 132.



Gigli's thread-saw. (Down Bros.' Cat.)

have formed there is no comparison between the state of such a scar and that resulting from a wide removal of bone with strict attention to the rule of modern surgery. This is certainly true of removal of bone in the temporal fossa. Mr. J. Hutchinson, Jr., whose experience and success in the removal of the Gasserian ganglion by the temporal

FIG. 133.



Steel director and whalebone guide for use with Gigli's saw.

Holes are first made with a small trephine, then the director makes a way for the whalebone guide, threaded with silk. The guide is withdrawn, leaving the silk *in situ*; the silk afterwards assists in the passage of the Gigli's saw. Objections to a guide made of whalebone are given at p. 373. (Down Bros.' Cat.)

route is well known, writes (*The Surgical Treatment of Facial Neuralgia*, 1905, p. 91; Sir F. Treves's *Manual of Operative Surgery*, vol. i. p. 225) that the large aperture left by trephining and bone-forceps "becomes so completely filled up with bone in a year or two that it can no longer be detected." Till recently the objections to the osteoplastic method were valid ones (1) that unless performed by complicated instruments not always at hand and involving especial experience in their *technique* the method was a prolonged one, especially in thick and compact skulls,

save in specially experienced hands, and (2) if performed by the very simple chisel and mallet it entailed what has appeared to many to be an unnecessary violence, and, perhaps, for there can scarcely be any proof here one way or another, a harmful degree of concussion of the brain (p. 292).

Now, however, Wagner's method has been so simplified, as will be seen below, that the above objections are no longer valid.

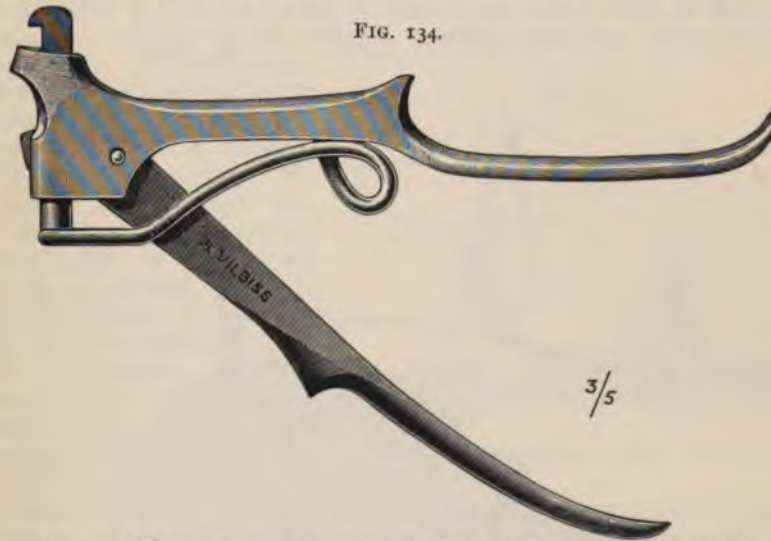
The course to be taken is, in my opinion, still an open one. On the one hand, if a surgeon who has necessarily not had especial experience prefers especially in his earlier cases to make use of the simpler method and so remove the bone he is entirely justified in doing so. Time and further experience alone will show whether the advocates of the osteoplastic flap and this only have been premature in their claim that this method is essential for sound surgery.

Before dealing in some detail with the different ways of *Removal of the Skull* a few words must be said about the hæmorrhage. This in large incisions of the scalp must always be free; in some cases where the growth is limited to the brain itself, it has been so profuse as to add gravely to the perils of the patient. The simplest method of meeting it is that described at p. 237. A fairly large drainage-tube sterilised and split longitudinally is carried once round the forehead above the roof of the nose and the ears and below the occipital protuberance and secured over a pad of gauze. There is no need to clamp the tubing very tightly, a step which is further objectionable from the risk which it entails of causing sloughing of the soft parts, in a prolonged operation. It must be remembered that the above step cannot be relied upon to always arrest the hæmorrhage from the scalp.* If it fail, the surgeon must, if not intending to employ the osteoplastic method, raise the flap rapidly including the periosteum, and seize each bleeding vessel, including the whole thickness of the scalp, with Spencer Wells's forceps, as advised at p. 252. As soon as the flap is partly raised an assistant can compress its edge between his fingers, relaxing his pressure over different parts of this in turn, as the operator takes up the vessels.

I will suppose that the surgeon who is not employing the osteoplastic method has turned down his flap, wrapped this in sterile gauze, arrested the bleeding, and removed the tubing. In order to remove the bone freely—and a cramped opening is certain to defeat the object of the operation—the following courses are open to him. He may make a large opening with a 2-inch trephine in the centre of the area to be removed, and then complete the removal with bone-forceps, such as those of Hoffmann. This is, however, always a very slow process, increasing

* Thus in a case of removal of a small spindle cell, encapsuled sarcoma of the brain and dura mater, in which the skull wall was hypertrophied and the diploë obliterated, reported by Dr. J. E. Owens, of Chicago (*Ann. of Surg.*, May, 1905, p. 695), "in spite of the fact that the head was encircled with an elastic band, hæmorrhage persisted even after a number of artery forceps had been employed. These, as well as digital compression here and there, were not sufficient to completely arrest the bleeding." After partial formation of an osteoplastic flap the completion of the operation had to be deferred owing to the alarming prostration of the patient, chiefly from loss of blood. The operation was completed about a week later, and then the hæmorrhage from the scalp was so free as to be only arrested by loosening the flap at the pedicle for the purpose of enclosing the latter in an elastic ligature. The patient recovered.

greatly the amount of anæsthetic necessary; in thick or sclerosed skulls Hoffmann's forceps may prove inadequate, and it is well to be provided with a pair of powerful forceps, such as those in Fig. 131, or Mr. A. Lane's fulcrum cutting forceps (*Lancet*, Nov. 10, 1894). A quicker method is to make four small trephine openings at the angles of the area to be removed, and then to join these by the powerful forceps shown in Fig. 131, or the forceps of De Vilbiss (Fig. 134), or by a Gigli's saw, as described below.* If the hæmorrhage on division of the bone, now, or with an osteoplastic flap, is severe—and this has been perilously the case on several occasions—the following suggest themselves, *e.g.*, pressure with sterile gauze wrung out of sterile adrenalin solution (1—1000); Horsley's wax; crushing the bone together—too much force must not be used or



Forceps of De Vilbiss, especially adapted for the division of the bones of the cranial vault.

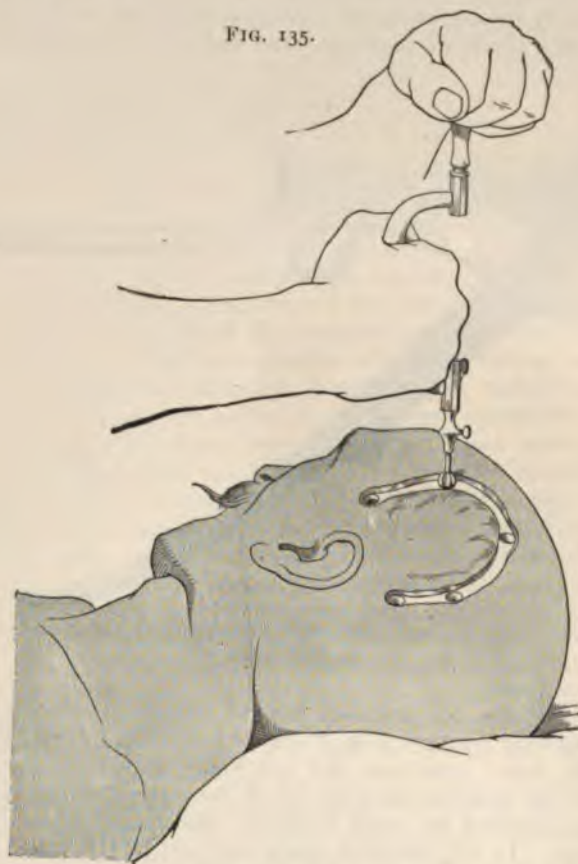
fresh channels are opened—the use of sterile wooden pegs; these failing, temporary compression of one or both carotids (p. 358).

The bone being removed, the surgeon decides by the pulse and condition of his patient the urgency of the case, and the report of the anæsthetist, whether he shall complete the operation or defer this to a later stage. In all doubtful cases this will be the wiser course. It

* Having in mind those for whom this book is written, I have said nothing about craniectomy with the aid of electricity. Trephines and other instruments worked by an electric motor or "surgical engine" require much skill and care in maintaining the dura mater uninjured. The cutting forceps of De Vilbiss (Fig. 134) are not as well known in England as they deserve to be. I owe my acquaintance with them to that most courteous and gentle of Americans, Dr. Rixford, of San Francisco. Those who wish to be familiar with the modes of removing part of the cranium by trephines and saws, worked with different motors, will find the needful information in articles by Dr. S. D. Powell, of New York (*Med. Ann.*, 1899, p. 513), and Dursdale, of New York (in the *New York Policlinic*, July 15, 1897), and Down Bros.' Cat., 1900, p. 115. See also the remarks, p. 244 of this book.

was advocated some years ago by Sir W. Macewen and Sir V. Horsley, and their advice is now being more largely followed. It is no exaggeration to say that if it had been taken oftener the mortality of this operation would not be so high. This step, as pointed out by Sir W. Macewen, not only diminishes shock, but also, if the dura be opened, by soldering the membranes at the margin of the exposed brain, shuts off the subdural space, and so prevents the escape of blood into it. The objections must not be forgotten, viz., the double anæsthetic, the two operations, and the difficulty of keeping the wound

FIG. 135.



The outline of the osteoplastic flap having been marked out by incising the soft parts and slightly separating the periosteum, five openings in the cranium are being completed with M. Doyen's burr. (Marion.)

sterile. If the above course is taken, all hæmorrhage is finally arrested, the flap is replaced, a few sterilised horse-hair sutures inserted, and the usual dressings applied.

Wagner's Method by an Osteoplastic Flap.—If, while we are still uncertain as to the exact condition of the cicatrix after extensive removal of bone with modern methods, the surgeon prefers to employ above, the following are amongst the many methods employed.

Of the chisel (Fig. 141) I have already spoken (p. 370). A far simpler method is to make four small trephine-openings—as they are small the loss of bone will be immaterial—at the angles of the area operated upon and then to join these laterally and above by the forceps of De Vilbiss or by Gigli's saw (Figs. 137 and 139). Where the bone is thin the forceps are most efficient, as I found in the case in which I employed them. But the saw has these advantages: it will divide thicker bone, and by the saw it is possible to bevel the edge cut, trenching on the outer more than the inner table, so that the osteoplastic flap when replaced shall fit accurately, and not sink in upon the brain.

M. G. Marion, of Paris, having tried nearly all the different methods of craniectomy, has come to the conclusion that much the most rapid is that by means of Gigli's saw (*Arch. Gén. de Méd.*, 26, 1904, p. 1025). I can entirely confirm this view from my own experience in two cases.

Here the operation, being done in two stages, the skull was first perforated with a small trephine. M. Marion claims that his modification is rendered more rapid in two ways; (a) by the manner in which he perforates the skull; (b) by his modification of the introducing director usually sold with Gigli's saw. While M. Doyen's trepan is shown in the accompanying figures, a small



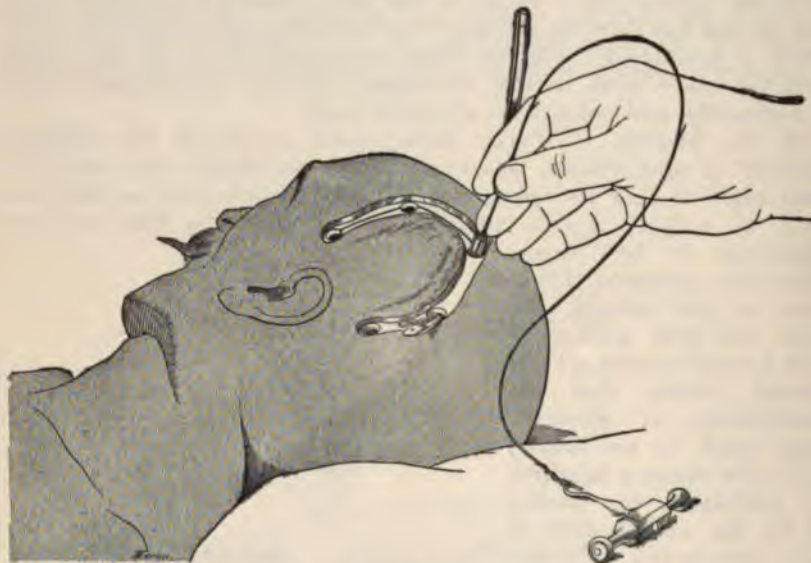
M. Doyen's perforator and burr. (Marion.)

trephine will serve the same purpose. As to the introducer the whale-bone guide usually sold will not stand boiling, and tends to fray and perish, though more slowly after sterilisation with carbolic acid. A flexible strip of copper and a loop of silver wire will supply all the needs of an introducer.

The flap of soft parts having been outlined by incision and the periosteum separated for about $\frac{1}{4}$ inch (Fig. 135), four, or more orifices, according to the size of the bone to be raised, are made with M. Doyen's trepan. "The perforator (Fig. 136) is first fitted on, and the bone is perforated down to the internal table very rapidly. Owing to the triangular shape of the perforator, with an almost blunt extremity, one can scarcely injure the dura mater if care is taken when the internal table is reached. As the deepest layers are reached the centre of the perforation becomes depressible. A peculiar sensation indicates that the skull is actually perforated. A burr (Fig. 136) being next substituted for the perforator—the burr should be sufficiently large, from 12 to 15 mm. in diameter—each orifice is enlarged until its dimensions, superficial and deep, are almost the same. The orifices are now joined by the saw. This is introduced by passing the director (Fig. 138) from one orifice to the next (Fig. 137), a step rendered easy by the elasticity of the director and by giving a slight curve to its extremity. The saw is then introduced along the groove, and if there

be any difficulty in doing this a thread* is first attached to the saw and drawn through." M. Marion has not found it necessary, in this case, in order to protect the dura mater, to reintroduce the director.

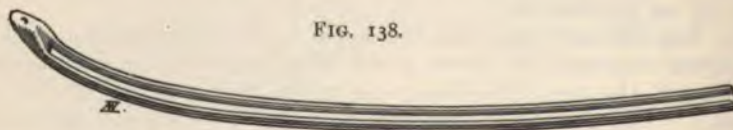
FIG. 137.



The cranium having been cut through up to the third opening, Gigli's saw is being passed from the third to the fourth opening with the aid of M. Marion's guide. (Marion.)

The first two holes are then joined by the saw. "The sawing is effected easily and rapidly (Fig. 139) if care is taken that the two ends of the saw are not held at too acute an angle, and the two hands and

FIG. 138.



M. Marion's guide for Gigli's saw. (Marion.)

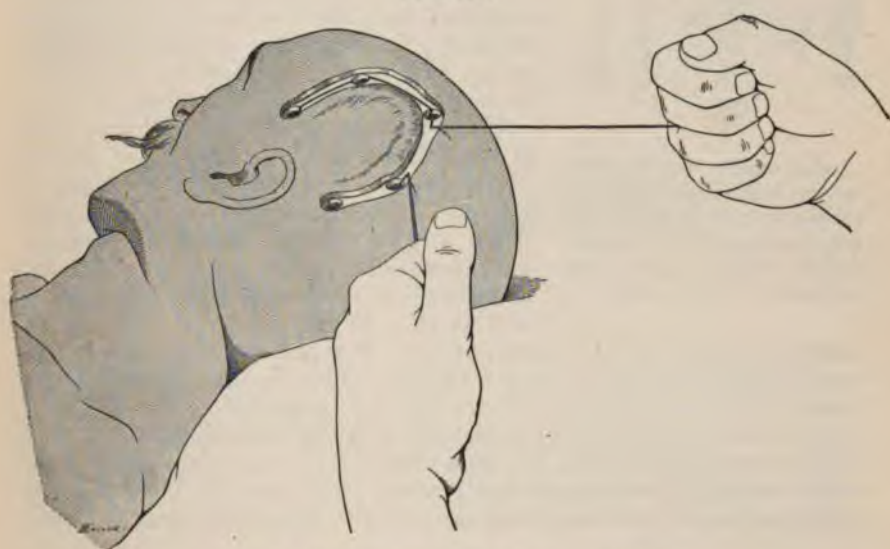
the angles of the saw kept in the same plane. Further, the section of the bone should not be made perpendicular to its surface, but a little obliquely from without inwards. When all the circumference of the flap has been thus treated, the saw is slipped down to the base of the flap, and this is partly sawn through, a step which greatly facilitates its fracture."

The following advantages are claimed by M. Marion for this method. (1) Only one special instrument, Gigli's saw, is required. In England

* Better, I think, a piece of fine silver wire.

M. Doyen's instruments may have to be added. (2) It is rapid and gentle. M. Marion claims that as large a flap as can be desired can be raised in less than five minutes. Here the "personal equation" must be remembered. The vibrations of any electrical apparatus are avoided and the need of any installation dispensed with. (3) The surface of the section is very clean and permits of the most exact readjustment of the flap. (4) There is no danger of wounding the dura mater. (5) By this means it is easy to saw through the base of the flap in part, a step which, if not indispensable, greatly facilitates the regularity of the line of fracture, a point which is not without importance in the readjustment of the flap. The only objection to the method is a small one. A saw may break, especially when used at too acute an angle or

FIG. 139.



Division of the cranium by Gigli's saw. (Marion.)

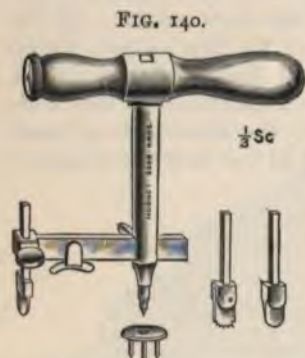
when the hands are worked in different planes. Several should be at hand. Their price is trifling.

Stellwagen's Trephine (Fig. 140).—This recently-introduced instrument, which combines the knife and trephine, is intended, while worked with the hand, to supply, in a great measure, the speed of craniectomy by electricity. I have no experience of it. As in the case of all new inventions it has been promptly and largely tested by American surgeons, some of whom, not all, speak very highly of it. Whether, now that operations for growths of the brain will often be performed in two stages, this instrument is likely to replace the simpler one given above by trephine and bone-forceps or Gigli's saw, time alone will show.

Advantages of Stellwagen's Trephine.—A large opening is rapidly made. From accounts of American cases the time varied, according to experience with a new instrument, from thirty to eight minutes. It does away with the risky jarring inseparable from the use of mallet and

chisel.* It makes the osteoplastic flap so accurately that the reunion is more certain and quicker.

One possible difficulty which the use of the above instrument may entail is thus noticed by Dr. Mills (*loc. supra cit.*). "The incision made by the knife carried by the arm of the trephine, when the flap is large, is of such length that it may be difficult to catch all the vessels cut as speedily as is desirable if the incision is made with a single sweep of the knife. It is therefore better that the knife-cut should be carried to a certain distance, the vessels then tied, the knife next carried round another portion of the circle, and so on."



Stellwagen's trephine, with saw and knife blades. The latter are used to incise the scalp. The arm can be adjusted to describe a circle of from $2\frac{1}{4}$ to $4\frac{1}{2}$ inches in diameter. (Down Bros.)

Where the scalp is very thick or œdematous and the plate does not fit closely into the bone, the semilunar flap must first be raised in the ordinary way and the plate then fitted directly into the bone.

Second Stage of the Operation.—This is undertaken after an interval of five to seven days.† If no more bone requires removal, and this should have been rendered unnecessary by the careful preliminary localisation insisted on at p. 366, local anaesthesia, as recommended by Dr. Ransohoff (p. 357), should be tried. The sutures are removed and the flap turned down and wrapped in sterile gauze. The next step is the *opening of the dura mater*. This should be incised round four-fifths of the circumference of the area exposed, at about $\frac{1}{4}$ inch distance from the edge of the bone, so as to render it possible to stitch the edges together afterwards. The dura mater is best opened first by incision with a scalpel or sharp-pointed bistoury, and then by blunt-pointed curved scissors, great care being taken not to wound the parts beneath :



Doyen's guarded chisel. (Down Bros.' Cat.)

tenaculum-forceps will be found useful here. The main branches of the middle meningeal are best secured by underrunning them with fine silk by means of a fully curved small needle before they are divided. The dura mater should be raised with much gentleness, as if any adhesions are torn, very free venous hæmorrhage may result (p. 279).‡

* It is only fair to Prof. Keen to say that in replying to this criticism of Dr. Mills he stated that he had opened the skull with a chisel and mallet in 150 cases, and that he had yet to see the first instance of mischief from this method.

† Prof. Kocher (*Operative Surgery, Stiles's Trans.*, p. 68) says that after fourteen days a flap, resected by the osteoplastic method, may still be readily opened up.

‡ Any of the dura mater which is adherent to the growth is usually much altered. If the mischief is recent, the membrane will be simply highly vascular. In advanced cases

Treatment of the Brain.—If this, after incision of the dura mater, bulges very prominently into the wound, it indicates pathological intracranial tension, and probably a growth. C. H. Frazier (*Amer. Journ. Med. Sci.*, Feb., 1904), calling attention to the fact that this bulging of the brain may be one of the most embarrassing features of cerebral operations, distinguishes between "initial" bulging, that which follows immediately on reflecting the dura, and is due to the increased tension caused by a growth, and "consecutive" bulging caused by the cerebral oedema set up in normal brain tissue by the exploratory manipulations. This far exceeds the "initial" form, and, as it is most embarrassing, exploration should be as expeditious as possible.* Alterations in the density of the brain must next be observed, but it must be remembered that the softer cerebral growths situated beneath the cortex are scarcely to be detected, save by exploratory incision; with tubercular nodules it is different. Dr. Weir (*loc. supra cit.*) thinks a needle of very little value in exploration of a growth. A tumour too soft to be detected by the finger will not be recognised by

FIG. 142.



Doyen's guarded saw. (Down Bros.' Cat.)

the needle. Furthermore, two cases have come to Prof. Keen's knowledge in which fatal hæmorrhage followed its use. Careful search with one of the instruments shown in Fig. 143, or palpation and the insinuation of the finger-tip under the opening are preferable. Prof. Keen (*loc. supra cit.*) points out that the brain allows of gentle pressure very readily, and that the finger can be inserted, for the purpose of examination, an inch all round the opening. The removal of a growth and the adjacent part of the brain is best effected by one of the instruments shown in Fig. 143. If a sarcoma be encapsuled, it may be shelled out

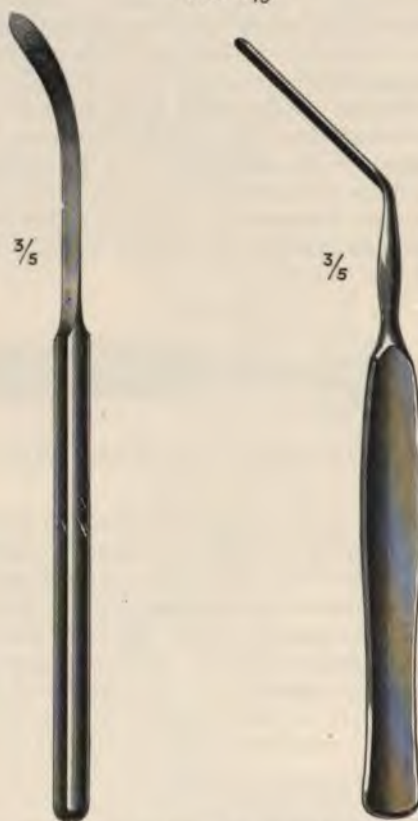
it may be yellowish, and in some instances, on separating it from the growth beneath, it is found to be of a dirty reddish colour. In all cases where it is adherent the dura mater must be freely excised, if possible.

* In some cases where there is abundant evidence of intracranial tension a growth may be present, but out of the range of the operation. Thus, in a case in which Dr. Weir (*Ann. of Surg.*, June, 1887) trephined over the upper part of the right fissure of Rolando for spasms in the left limbs and loss of power in the left leg, no growth was found. Death took place ten weeks later, and a spindle-celled sarcoma, apparently originating in the pia mater, was found springing from the lower surface of the left cerebellar lobe, displacing the medulla forwards to the right, and invading the fourth ventricle. Dr. L. S. Pilcher (*Ann. of Surg.*, March, 1889) relates the case of a man who presented symptoms which, though not very definite, were not inconsistent with the existence of a growth in the left angular gyrus, or its immediate vicinity, the site of a previous injury. Trephining being performed, the dura mater and brain projected so strongly that, after the former had been reflected, a rent took place in the cortical portion, $\frac{1}{4}$ inch deep. No growth was found, and the patient died thirty-eight hours later with pulmonary oedema. The necropsy showed an infiltrating glioma in "the anterior half of the left hemisphere."

by one of these aided by a finger. But we are as yet without knowledge whether such capsules are sarcomatous, or only inflammatory.

Hæmorrhage.—In removing a portion of the brain, or a growth, the bleeding which has been so much dreaded will usually cease if the wound be packed for a few minutes with strips of iodoform gauze wrung out of sterile saline, or adrenalin solution, 1 in 1000. If it

FIG. 143.



Combined blunt dissectors and spatulae used by Sir V. Horsley. They are equally adapted for the protection of the dura mater under the saw, or for the separation of a growth from the surrounding brain. They also act as flat probes in testing the depth of trephine-holes.

recur, the strips must be lightly twisted together, left in, and their ends brought out at one of the lower angles of the wound. The value of a preliminary injection of morphine has already been alluded to, and Sir V. Horsley further points out that, owing to the fact of the main vessels remaining in the pia mater, they can be raised from the brain, and especially out of the sulci, so as to allow of the subjacent brain being removed. Other means of arresting hæmorrhage are boiling sterile saline solution, cooled to 105° or 110°; fine catgut ligatures tied without jerking, and not too tightly; or Mr. Ballance's method (p. 350). Sir V. Horsley has invented a combination of fine dissector

and small aneurysm-needle well adapted to facilitate underrunning and ligature of the vessels of the pia mater. If any bleeding vessel is not well within reach, the opening must be enlarged to get at it. When other methods fail—and careful plugging and firm pressure with knotted bandages over the dressings has failed more than once—small Spencer Wells's forceps may be left on for thirty-six or forty-eight hours; but the patient must be carefully watched, lest his restlessness cause the friable tissues to give way, or inflict damage on his brain. The treatment of hæmorrhage from the meningeal or diploic vessels, or any of the large venous sinuses, has been given at pp. 248, 265 and 371.

Incision of the Brain.—The cuts in the cortex must be made exactly vertical to the surface. If possible, portions of each centre should always be left, so that the representation of its movements may never be totally destroyed. A portion of brain removed does not leave, as might have been supposed, a permanent gap with vertical sides, for, in a very short time, the corona radiata forming the floor of the pit bulges almost to a level with the surrounding cortex.

*Difficulty in Detecting the Growth.**—This may arise from several causes. (1) The want of distinctness in the growth—in other words, its close resemblance to brain substance.† (2) By the growth being overlaid by normal brain tissue (pp. 348, 361). (3) By change in the growth—viz., hæmorrhage from its thin-walled vessels, and, later on, cessation of the coagula; these conditions being likely to puzzle the operator.

Difficulty in Isolating the Growth.—(1) This may be due to the absence of a capsule, and thus to the infiltration of the surrounding parts. Now that gliomata, owing to the operative attacks which will be made upon them, are of such practical importance from a new point of view, this question of a capsule is a very weighty one. It seems to be a disputed point. Thus, in Dr. Bennett and Mr. Godlee's case the glioma was found to be "thinly encapsuled, but quite isolated from the surrounding brain-substance." Not so, however, is it in many other cases. Indeed, the chief pathologists speak decisively on this point. Dr. Fagge (*loc. supra cit.*) wrote: The substance of glioma "is always continuous with that of the surrounding cerebral tissue, for there is never a capsule‡ as with some sarcomata. Indeed, it often assumes the form of the part in which it grows, so that one might imagine the corpus striatum or the thalamus, or some particular convolution, to have become swollen to three or four times its usual size." Mr. Bland Sutton (*Tumours, Innocent and Malignant*, p. 174), writes: "Virchow pointed out that when a glioma is situated near the surface of the cerebral cortex it appears like a colossal convolution."

Dr. Ferrier (*Brit. Med. Journ.*, Oct. 1, 1898, p. 966), says on this point: "It is unfortunately the case that a large proportion of the

* I have confined myself here to gliomata, the commonest of cerebral growths.

† "A glioma may be of a pinkish-red colour, or it may look so exactly like the normal brain substance that a microscope is required to demonstrate its presence."—Dr. Fagge, *Medicine*, vol. i. p. 523.

‡ The glioma "is distinguished by having no capsule, but merging indefinitely into the tissue around."—Sir S. Wilks and Dr. Moxon, *Path. Anat.*, p. 239.

tumours which invade the brain are of an infiltrating character, and apt to recur in spite of apparently the most complete extirpation. One can scarcely hope for a cure, therefore, under such conditions; but, nevertheless, there are many cases in which extirpation of such tumours has, for a time at least, rescued the patient from impending coma and death, and restored him for a time to clearness of intellect and a fair degree of comfort." A little later on we are advised that, "It is, on the whole, better not to attempt to remove a tumour which proves to be a soft infiltrating one without distinct demarcation from the healthy brain substance."

This, or the partial removal of a growth which cannot be entirely got away must remain, I think, an open question. On the one hand partial removal may cause further very serious hæmorrhage, when the patient is least fitted to stand this. On the other hand, the tension may be so great—the "initial" and "consecutive" bulging spoken of at p. 377—that unless some of the growth be removed it will be impossible to draw the dura mater together. Further, Mr. Ballance's cases (pp. 349, 361), show that life may be prolonged for over four and for nearly three years, after operations probably incomplete. And Fischer's case (p. 364) points in the same direction, though to a much less degree. In cases where removal is obviously incomplete, it would be justifiable to try the application of a strong solution of formalin, as advised below in inoperable sarcomata (*q.v.*).

(2) Another source of doubt in telling when a glioma not encapsulated has been isolated, arises from the fact that, as pointed out by Dr. Fagge (*loc. supra cit.*), these growths, in common with all the less circumscribed form of cerebral tumours, are apt to set up morbid changes in their immediate vicinity, usually of the nature of softening, partly inflammatory, partly œdematous.

If a cyst be found it should be completely removed if possible. If this be not feasible, all the more superficial part should be cut away, the interior wiped over with a stick of silver nitrate or strong solution of formalin, and packed with iodoform gauze.

I have spoken hitherto only about growths on the cerebrum. Unusual difficulties must always attend **operations on the cerebellum**, owing to the limited space, the numerous sinuses, and the vicinity of the medulla and its centres. The older-fashioned method of a large trephine and then enlargement of the opening is probably safest here. When the growth, especially a cyst, is limited to one lateral lobe, access, though cramped, can be given in this way. When the growth arises in the middle lobe and peduncles, the difficulties are probably unsurmountable. The growth can no doubt be exposed by making two trephine openings as near the middle line as possible, cutting away the intervening bone and ligaturing or clamping the occipital sinuses. But even when a sufficient opening has thus been made, whether a central growth can be removed safely, considering its surroundings, must be extremely doubtful (Mills).

A recent and authoritative account of the surgical aspects of growths of the cerebellum has been given to us by Dr. C. H. Frazier (*New York Med. Journ.*, Feb. 11, 1905).

An abstract of the article by Dr. R. W. Murray will be found in the *Medical Chronicle*, June, 1905.

Elevation of the head and shoulders are advised. The hæmorrhage is thus diminished and its harmful effect on the blood pressure is counteracted by bandaging the extremities. Extension of the head on a rest attached to the table will give greater freedom to the operator. An incision is made from the tip of the mastoid and following, but 1 cm. above the superior curved line to the middle line. From this point it is carried vertically downwards. To meet the bleeding, always free, the flap should be raised bit by bit, the hæmorrhage being arrested as the operator goes on. The venous sinuses traversing the occipital bone, especially one near the mastoid process, may cause alarming bleeding. The opening in the bone is made with a trephine midway between the external occipital protuberance and the mastoid, and enlarged in all directions, outwards to the mastoid process, upwards till the lateral sinus is fully exposed, inwards to a point 1 cm. from the middle line, and downwards to one within a like distance of the foramen magnum. An osteoplastic flap is unnecessary here owing to the sufficient protection given by the thickness of the scalp.

If, at this stage, the patient's condition continue good, the operation should be completed; otherwise it is well to defer this to a second stage. A large dural flap (p. 376), having been reflected downwards, if the cerebellum protrude much, the presence of a growth or hydrocephalus is probable. If a growth in the lateral lobe be suspected the cerebellum should be incised, the growth felt for with a sterilised finger, and extirpated if it be found.

If on the other hand there is reason to suspect the presence of a growth at the cerebello-pontine angle, a favourite site, the subsequent steps are far more difficult. Owing to the increased tension it will probably be impossible to displace the cerebellum sufficiently with a retractor to expose the growth. Either the ventricles must be punctured or part of one cerebellar hemisphere removed. Dr. Frazier considers puncture of the ventricles so often fatal as to be unjustifiable. On the other hand, removal of a large part of one cerebellar hemisphere has given marked relief in several cases, though no growth was found. Thus blindness, headache, vertigo, have all been greatly relieved.

The shortest route to the cerebello-pontine angle is along a line parallel to the petrous part of the temporal bone. Provided the opening in the bone is extended as far outwards as possible, one may after retracting the cerebellum inwards obtain a view not only of the seventh and eighth nerves as they enter the internal auditory meatus, but also of the sensory root of the fifth at the apex of the petrous bone.

The need of the greatest care in all manipulations of the cerebellum, especially near its centre, is inculcated, owing to the risk of bruising the medulla and pons.

In the same number of the *Medical Chronicle* will be found papers by Dr. Williamson and others on Growths of the Cerebellum. The following case is a good instance of the way in which the site of a growth here, though producing well-marked symptoms, may cause insuperable difficulties in its removal.

A woman had suffered from occipital headache, vomiting, failing sight, and tendency to fall to the left side. On removal of the brain at the necropsy, the left half of the cerebellum appeared normal. It was only after making sections and careful examination that

a small growth was found in the left amygdala. It was a mixed cell sarcoma of the pia mater of the cerebellum and the choroidal plexus of the fourth ventricle.

Closure of the Wound.—All bleeding having been stopped, the cut dura mater is sutured with fine sterilised silk or catgut. If the brain bulges much when the dura mater is being sutured, it should be depressed with a copper spatula, while the edges of the dura are, if possible, quickly brought together by a continuous suture. If necessary, a flap of pericranium must be employed, as advised by Prof. Keen, p. 360. Room must be left for drainage, and the flap adjusted with salmon-gut and horsehair sutures. Sir V. Horsley removes the drainage-tube, which is to be inserted at the most dependent part of the incision (as the patient lies in bed), at the end of twenty-four hours, and makes firm but gentle pressure over the centre of the flap. The tube serves to remove the steady oozing of blood and serum from the cut surfaces, which takes place during the first twenty-four hours, and its removal at the end of this time is advised, in order to allow of a certain amount of tension from wound exudation to occur within the cavity; this tension not interfering with primary union if kept within proper bounds, while it secures pressure on the brain which is tending to extrude, and serves, when the wound is finally healed, to separate the skin-flap from the brain beneath by a cushion of soft connective tissue. If, after the removal of the tube, there is much pain and throbbing in the wound, and the union threatens to break down, the edges must be sufficiently separated with a probe, gently used, in the track of the drainage-tube.

I have said nothing about the replacement of bone in those cases where the osteoplastic method has not been employed, as the operation will often be done in two stages, and, thus, the bone will not have survived the interval. As I have said before, we want exact evidence as to how far large gaps, over which healing has taken place rapidly, need further protection, as by a perforated celluloid plate.

And there is no need for me to impress upon my readers the need of preventing and meeting shock in every possible detail before, during, and after the operation. While the patient is still under the influence of the anæsthetic, saline fluid should be injected into a vein (p. 140), and this should be followed up by injections into the cellular tissue, large enemata, and strychnine. Owing to the state of mental tension and preoccupation which a grave operation entails, it is still too much the habit of operators to wait for shock and then to meet it vigorously. I venture to think this a mistake. In such cases shock should be expected as a matter of course, not waited for.

Excision of Cortex Centres for Epilepsy.—I have referred to this matter fully at p. 281. As this is an operation which may be repeated in the future, it will be well to mention one case in which Prof. Keen, of Philadelphia (*Amer. Journ. Med. Sci.*, Oct. and Nov., 1888), excised the centre for the left wrist and hand in an epileptic whose fits always began in the left hand. Marked success followed the operation; but the need of watching any case for a long period before a success is claimed has been fully explained at p. 275.

The patient, aged 20, had had a fall on his head when 13. There were no definite traces of this, and exploration of the part which had possibly been struck detected nothing abnormal. Each fit invariably began in the left arm and fingers. The thumb and fingers

became rigid and extended, widely separated, the hand and forearm in a right line, and the elbow flexed. Usually both legs were then attacked, the left usually before the right, and crossed in front of it; next, the face, the mouth being drawn to the left. After this the convulsions became general.

The fissure of Rolando having been marked on the scalp; in order to indicate it on the skull itself, two small incisions were made at the ends of the line, and with a bone-gouge two small circles were made through those on the skull. A $1\frac{1}{4}$ -inch trephine was then applied with the centre-pin $\frac{1}{4}$ inch behind the fissure of Rolando, the lower margin of the trephine being about $\frac{1}{4}$ inch above the temporal ridge. The crown was placed in 1-2000 bichloride solution, carefully kept at T. 100° - 105° . The bone and dura mater both appeared normal; no bulging was observed, and the pulsation was regular. The dura was now incised. The pia was very much infiltrated with serum, producing an œdematous layer much obscuring the brain tissue, especially the sulci over all this area. Two convolutions, running obliquely downwards and forwards, crossed the trephine-opening, while at the interior border a third convolution, with, apparently, a like direction, came into view. An attempt was made to determine which was the Rolando fissure, by examining the depths of the sulci, but as both were about 1 inch deep, this gave no clue. By the cyrtometer (disinfected) the position of the fissure of Rolando was re-determined. This ran in the middle of the three convolutions. To determine the seat of the hand-centre a faradaic battery was used, the ends of the wires being wrapped in borated cotton dipped in bichloride solution. Stimulating the two posterior convolutions gave no results. When the anterior one of the three was touched the hand instantly moved, the wrist and fingers being extended. Above this centre were the shoulder and elbow centres, and below, that for the face. The opening in the skull was now enlarged, and the portion of the hand-centre about $1\frac{1}{4}$ inch long, as ascertained by the battery, was then incised above and below with a knife, the lower incision being $\frac{3}{4}$ inch above the temporal ridge. The lower end of the portion to be removed was then lifted up, and the loosened convolution cut away with scissors. While this was done, no movement was perceived. The battery wires were now again applied. At the remaining part of the convolution above, flexure and extension of the left elbow, elevation and abduction of the shoulder, were noticed. Touching the part remaining below produced an upward movement of the whole left face. The large vessels in the brain were extremely gently tied with chromic gut, and oozing checked by hot water and cocaine (4 per cent.). The dura mater was sewn with chromic gut, two bundles of horsehair being placed beneath it. The disc of bone and some fifteen pieces removed were replaced on the dura. Soon after the patient recovered from the ether he had a fit, but the hand did not move. The patient made a good recovery, and a month after the operation the skull was as firm on one side as the other, with very slight, if any, irregularity where the pieces of bone were replaced. The fits were greatly diminished, and only of a momentary character, practically *petit mal*. There was no convulsive movement whatever; the hands and wrist were as before. Seven weeks after the operation the patient wrote that motion was returning in the left hand. Prof. Keen thought that by "compensation" it was nearly certain that in time control over the left hand would be regained through the other hand-centre.

The above remarks refer to attempts to remove certain definitely localised small centres. The following words of Sir W. Macewen (*Brit. Med. Journ.*, Aug. 11, 1888) have an important bearing on this matter, and, from his wide experience, carry great weight: "Can the motor area be removed in large pieces with immunity from serious consequences? If this region be of such psychical importance to movement, and destructive cortical lesions in it are followed by secondary degeneration of the motor tracts, then excision of these areas will necessarily induce permanent paralysis, late rigidity, and ultimate structural contracture. The removal of large wedges from the brain, especially in the motor centres, will produce serious effects upon the brain as a whole, causing, during cicatrisation, a dragging and displacement of the neighbouring parts, with final anchoring of the

cerebrum to the cicatrix.* . . . In the presence of a stationary cicatrix, or a slow-growing neoplasm in the motor area, occasionally producing fits, few would attempt the removal of such a large wedge of the motor region as to induce permanent hemiplegia. Even when the fits are much more numerous and aggravated, it is serious to contemplate the production of hemiplegia while attempting the cure of the fits. No doubt these epilepsies, when long continued, especially in early life, are apt to lead to great and extensive instability of the motor cortex, so as to warp the whole cerebral function, and ultimately involve life itself. Still, how much better is the cure by the removal of a large wedge, involving the greater part of the motor area? How many people would submit to have their upper and lower limbs on the same side of the body amputated at their proximal points—for this is what the hemiplegia amounts to—in the process of cure of their fits? Numerous epileptics have been asked the question by me, but none have expressed their willingness to undergo such a cure. Even had they done so, the circumstances would require to have been exceptional to induce one to hazard the life of the patient for so poor a result. . . . Nor is the removal of very large tumours and large wedges of brain free from immediate peril to life. In several instances operated on elsewhere death has ensued—one while the tumour was being removed, and one immediately after the completion of the operation."

Causes of difficulty in cerebral operations and of their not doing well. Most of these have been fully alluded to.

1. The anæsthetic not being well taken (pp. 242, 367). The possibility of employing local anæsthesia in the second stage of the operation has been pointed out at p. 357.

2. Hæmorrhage (pp. 376, 378). This has been alluded to before, and on p. 370 a case of profuse hæmorrhage from the scalp has been given. Dr. Ransohoff (*Trans. Amer. Surg. Assoc.*, 1903) records a case in which the hæmorrhage met with during the removal of the bone proved actually fatal.

"An osteoplastic resection had been commenced, and about one inch of the bone cut through when profuse bleeding occurred, which was not arrested by plugging with Horsley's wax. The bone was rapidly removed with a trephine and bone-forceps in order to get at the source of the hæmorrhage, but death took place just as the dura was reached. A glio-sarcoma, the size of a small peach, not adherent to the dura, was found just

* "*Anchoring of the Brain, and some of its Consequences.*—When injury has been inflicted on the surface of the cerebrum, followed by plastic effusion and cicatricial formation, the superficial substance is apt to become soldered to the membranes when these remain intact, which in turn may be soldered to the skull, or, in the event of their detachment, the brain may become directly adherent to the bone. Thus, the surface of the brain becomes anchored or soldered to its rigid walls. It has no longer the free play within its water-bed to expand and contract according to the varying states of the circulation. Each variation produces a dragging of the brain at the spot, and through it the whole hemisphere at least is affected. Any sudden physical effort pulls on the brain, producing a slight shock, a momentary disturbance just as if the cerebrum had received a blow. Vertigo results. People affected in this way cannot rise up quickly, or perform any sudden movement of the body or head, without experiencing a sensation of giddiness, which sometimes causes them to drop. Following upon this, the grey matter of the cortex, immediately surrounding the cicatrix, by the incessant movement is apt to become unstable and produce fits. Some cases of traumatic epilepsy are thus caused."

under the trephine-opening. The diploic veins in the neighbourhood of the opening were much enlarged. There had been no unusual bleeding from the scalp. Raising the patient into the upright position was of no avail, and there was no time for ligature of the carotid."

In two cases the hæmorrhage has occurred some little time after the operation, and has been due to the vomiting after the anæsthetic.

3, 4, and 5. Difficulties in sufficiently exposing the area occupied by the growth, in detecting, and in isolating the growths.

6. Shock. Many of the causes of this are sufficiently obvious. I may allude to one which has not received mention, *i.e.*, the interference with subjacent parts of the brain, or the opening of a lateral ventricle in the removal of a deeply lying growth.

7. Edema of the lungs. This is especially likely after prolonged operations, where it has been needful to give ether, and in cases where, for some time before the operation, the patient has been practically bedridden, and the functions at a very low ebb.

8. Hernia cerebri. This may occur in two ways: (a) Immediately, during the operation, in a case where there is much evidence of intracranial pressure, and where it has not been possible to remove the cause. Thus, in a case of Dr. Pilcher's (*loc. supra cit.*), the projecting cerebral mass was so great in volume and so tense that there was no possibility of returning it within the cranial cavity or of covering it by the usual flaps. Accordingly it was sliced down to the level of the bone. (b) Later on, it may point to unrelieved tension, as in a case of mine of cerebral abscess to which I have alluded (p. 310), and in which a good recovery took place after evacuation of the re-collection of pus. In such a case constant pressure with the aid of a piece of sheet-lead, notched or perforated for the drainage-tube, will be found most useful. In other and more numerous cases a later hernia cerebri indicates infective changes. Sir W. Macewen thus points out another cause:

"It is true that round many neoplasms there is a zone of encephalitis, and, should this be extensive and of the nature of red softening, false hernia cerebri is prone to form. It was supposed that false hernia cerebri was entirely due to decomposition, many recent writers averring that it cannot occur unless when operations are conducted non-antiseptically, basing their belief on experimental investigations conducted on brains in a physiological state. Had they concluded that the formation of false hernia cerebri, after operations, was principally caused by decomposition, and always so when it occurred after operations on a physiological cerebrum, they would have been right. The consistence of false hernia cerebri is identical with red softening of the brain occurring in idiopathic affections in which there had been no operation. In one instance, in which trephining was performed for the relief of pressure causing total hemiplegia, and where the symptoms indicated either acute encephalitis or abscess, or both, the moment the dura mater was opened a large mass of encephalitis protruded through the membranes, forming a false hernia cerebri on the surface of the scalp. This encephalitis was not occasioned by septic matter introduced through a wound, as it occurred the moment the wound was made. Around neoplasms red softening sometimes exists, and interference might possibly occasion an extension of the affection, though were the operation conducted with strict antiseptic precautions the possibility of its formation would be reduced to a minimum. With this exception, there has been no false hernia cerebri after any of my operations."

9. Impossibility of complete removal.

10. I have spoken before (p. 242) of the liability of patients, with increased intracranial pressure caused by growths, to sudden and

unexpected death. Dr. Ferrier (*Brit. Med. Journ.*, Oct. 1, 1898, p. 965) gives two instances in which such sudden death occurred. In one a growth, the size of an hen's egg, was found at the necropsy, under the cortex in the area of Rolando; while in the other the symptoms pointed to a growth in the upper part of the same area. Dr. Ferrier points out that had these deaths occurred on the operating-table they would undoubtedly have been attributed to the operation.

11. Septicæmia and allied conditions.

12. Reappearance of the growth.

TREPHINING FOR MICROCEPHALUS, IDIOCY, ETC. LINEAR CRANIECTOMY.

Lannelongue's suggestion of invoking the aid of surgery in the treatment of imbecility (*Bull. de l'Acad. des Sciences*, 1890, and *Union Médicale*, t. i. 1890, p. 42), &c., aroused much interest, and in the immediately succeeding years a large number of cases were submitted to craniectomy, with a view of either removing some morbid condition or relieving pressure on the brain, or in some way stimulating its development. Like several other advances of modern surgery, it has not been based on the sound foundation of pathology or common sense. I refer to the pathological conditions and their hopelessness, and also to the poor vitality of these patients and their unfitness to be subjected to severe surgical operations. The results, as might have been expected, have been very unsatisfactory.

Before we can decide how far such operations are likely to be established procedures, we must consider what **pathological conditions are likely to be met with, and how far they are remediable**. These appear to be (Starr),—(i.) **Microcephalus**, whether due to premature closure of the cranial sutures (Virchow), or secondary to mal-development of the brain (Broca). In the following conditions the brain is at fault, with or without marked microcephalus, and sclerosis and atrophy are met with in a varying degree in nearly all. (ii.) **Porencephalus**. By this is meant a localised atrophy, leaving a cavity in either cerebral hemisphere, which may be deep enough to open into a lateral ventricle. (iii.) **Mal-development and atrophy of the minute structure of the cortex** of the hemispheres, without any gross defects. (iv.) **Meningo-encephalitis**, leading to thickening of the meninges and atrophy of the cortex. (v.) **Cysts** perhaps containing blood (p. 390). (vi.) **Hæmorrhage** on or in the brain. (vii.) **Hydrocephalus**. This last will be considered separately (p. 392). It is obvious, first, that many of the above are only to be recognised by exploration, and that most of them, if found, are hopeless of improvement. Thus it is clear that where sclerosis and atrophy are present to a marked degree, in cases of porencephalus, where one entire hemisphere is converted into a cystic cavity surrounded by shrunken brain-tissue and thickened arachnoid, interference will be futile. In the latter it may be fatal by the shock that will follow on the withdrawal of a relatively large amount of cerebro-spinal fluid. We have seen (pp. 278, 360) that in cases where a cyst is found a good deal may be done by surgery, and the same may perhaps be the case where a surface hæmorrhage is not too firmly organised. Microcephalus, the condition for which linear craniectomy was introduced, deserves a separate notice.

Dr. J. Griffiths, of Cambridge (*Proc. Med.-Chir. Soc.*, March 8, 1898), shewed that the skulls of microcephalic idiots may be classified under the following groups:—(a) The skull is of normal shape and outline, but small, ill-developed, and ill-filled. There is no premature synostosis

of the sutures. (β) The skull is not only small, but deformed from unequal growth. Whether this deformity is due to primary disease or the bones or premature synostosis of several of the sutures, or whether it is due to disease as well as defective growth of the brain, is still an open question. As in one form of microcephaly the brain itself is generally defective in the power of growth, its development having been arrested at an early period of embryonic life, and as in the other there is, in addition to arrested development, disease of the brain substance, and as the existence of cases of microcephaly in which premature synostosis has been able to impede or dwarf the growth of a normal brain is, as yet, quite hypothetical, craniectomy can be productive of no permanent good, the original fault being in the cerebrum and not in the skull.

In recommending operative steps the wise surgeon will be careful not to be too sanguine, remembering the nature of many of the conditions which he may meet with, and the impossibility of improving some of them. There is great weight in the words of the late Prof. Agnew, that, "Nothing perhaps exhibits the enthusiasm of modern surgery more than these attempts to coax an undeveloped idiotic brain to execute the orderly functions of intelligence."

Furthermore it must be remembered that here, as in trephining for epilepsy (pp. 273, 274), cases have been reported much too soon to be looked upon as successes. One of the most instructive proofs of this is given by M. E. Blanc (*Loire Méd.*, Dec. 15, 1898; *Epit. Brit. Med. Journ.*, Jan. 14, 1899). He gives later details regarding seven cases in which craniectomy was performed for microcephalic idiocy. The first two cases were operated on in 1891, the third in 1893, and the other four since. In all there was the most evident and immediate improvement, then the condition became stationary, and finally there was a return to the primitive condition. The flashes of intelligence which had been noticed were extinguished, the face became expressionless; signs of excitement reappeared, such as weeping, laughing, inarticulate cries, and convulsions; walking also became difficult and hesitating, as it had been before the operation. All the ground so slowly and painfully gained was lost. M. Blanc is of opinion that the difference in the results is due to the nature of the microcephalic idiocy. When one has to do with primitive microcephaly (the most frequent form) one cannot expect a permanent good result from surgical intervention, for the arrest in brain development takes place at the fourth month of intra-uterine life. When, however, one has to do with post-embryonic or later microcephaly (which is the exception), it is permissible to give a more hopeful diagnosis. M. Blanc is not favourably impressed with Doyen's temporary hemi-craniectomy, or Laboulay's mobilisation of the cranial vault. If the microcephaly is of the later variety, the ordinary procedures are sufficient; if it is primitive, no intervention, however extensive, will be successful—it is not the cranium but the brain which is at fault. The second point is, that we are here dealing with very vital parts in patients of poor vitality, and that, unless the surgeon is careful not to attempt too much, death from shock will be a very present danger.

Thirdly, many fatal cases have not been published, and we do not know what the mortality of this operation really is. Dr. Jacoby published

(*New York Medical Record*, May, 1894), a collection of 33 cases, of which 14 had died and 19 recovered, giving the very high death-rate of 42 per cent. Dr. Dana (*Pediatrics*, March, 1896) collected 81 cases, many of which had been recorded in Dr. Jacoby's article. Of these 81, 24 died, 35 were improved, and 24 showed no improvement. The death-rate of this collection of cases was 29 per cent.

Before leaving the question of the advisability of operative interference in microcephaly, I will quote the conclusions of Prof. Keen, of Philadelphia—conclusions which are most valuable on account of his long experience in operative surgery, and especially from his well-known skill in operations on the head and brain. Prof. Keen has performed craniectomy in 18 cases of microcephaly, the youngest patient being eighteen months, and the oldest seven and a half years old. In 5 cases the operation was fatal; in 6 cases slight improvement followed; in 7 none at all. Prof. Keen's conclusions are as follows:—No good can be expected from the operation in cases with average-sized heads, nor in those with extreme microcephaly, nor where the patient is over seven years old. In one case a restless, mischievous idiot was transformed by the operation into "a quiet, sleepful child"; but the improvement, when there is any, is usually slight. Much depends on special education after the operation. In some cases of moderate microcephaly the operation is justifiable, and in a small number of cases a slight improvement will follow; but in the majority there will be no result, good or bad; while in a definite proportion (15 per cent.) "the operation will happily be followed by death" (*Journal of Nervous and Mental Diseases*, Feb., 1898).

J. Chalmers Da Costa adds the weight of his opinion to the above (*Journal of Nervous and Mental Diseases*, June, 1904). "Microcephalus is not the result of premature sutural ossification. A microcephalic brain is not a more or less normal brain of very small size, the idiocy resulting from the smallness of the parts present, but is always an abnormal and undeveloped, and, in a great many cases, a diseased brain. If a strip of bone is removed from the skull new, normal brain cells will not be produced. Parts that are entirely absent cannot be created, and powers that do not exist cannot be called into being. The reported improvement, if continuous, is not due to the operation, but to proper instruction and care. The proper treatment for microcephalus is educational, hygienic and disciplinary." This writer puts the mortality as "nearer 15 per cent. than 2 per cent. as alleged."

Operation.—We will take first a case in which there is marked microcephalus, in which, perhaps, premature ossification is the cause of the trouble. Lannelongue (*L'Union Médicale*, Juillet 8, 1890) operated in his first case as follows: Having made an incision through the scalp and pericranium just to the left of the sagittal suture, a small circle of bone was removed with a trephine, a finger's breadth from the suture; from this as a starting-point, a narrow strip of bone was cut out parallel with and to the left of the sagittal suture, extending from the coronal to the lambdoid suture. The periosteum was not replaced. Sir V. Horsley removes the periosteum over the bone to be excised. This last step he effects by making parallel saw-cuts backwards and forwards from the trephine-opening, and then removing the bone

between the saw-cuts with sharp-pointed bone-forceps,* the dura mater being first detached with an elevator. In some cases, in addition to the removal of bone parallel to the sagittal suture, a second narrow strip has been removed over the corresponding fissure of Rolando.

Dr. Roswell Park (*Med. News*, Dec. 2, 1892) adopted this step in two cases, in one with great improvement, in the other with practically no good result. Sir V. Horsley did the same in his second case, but considers it unwise and doing too much at one time. His case died with hyperpyrexia attributed to disturbance of "the cortical thermotaxic centres." Sir Victor, who was the first to bring the subject of craniectomy in these cases before the notice of English surgeons (*Brit. Med. Journ.*, 1891, vol. ii. p. 579), operated on another case which at first showed some improvement. Later on, this child had been operated on four times. Dr. Telford Smith (*Journ. Ment. Science*, vol. xlii. p. 64) considered that there was no improvement in the mental condition which could be attributed to the operation.

My personal experience is limited to one case.

The skull here, in a child of $3\frac{1}{2}$, was normal in shape and outline but distinctly small and ill-developed, when comparative measurements were made with the skull of a normal child at the same age. The parents were eager for operation, which had been strongly advised by their medical man. I operated on the right side first. A flap having been raised, a small crown of bone was removed with a trephine just above the horizontal part of the lateral sinus. From this point an incision was carried forwards, parallel with the sagittal suture, to the roots of the hair in front. A narrow strip of periosteum having been removed, a like strip of bone was quickly cut out with the forceps of De Vilbiss (Fig. 134). A week later the house-surgeon, Mr. G. B. Thomas, performed a similar operation in the left side. On neither side was there any premature synostosis of the lambdoid and coronal sutures. An uninterrupted recovery followed. The parents who, two years later, were delighted at the result, brought up the child from Wales. I was unable to satisfy myself that the improvement was really due to the operation, and the time that had elapsed was too short.

In other cases there is distinct asymmetry or evident mal-development of part of the skull, especially the frontal region, as in a case of Dr. Starr's (*loc. supra cit.*, p. 148), where a marked difference could be seen between the size of the frontal bone and that of the posterior part of the skull. Dr. McBurney operated as follows:

The object in view being to allow of growth of the frontal lobes, it was thought best to lift the bone away from the brain on both sides. The left side was first operated on and, two weeks later, the right. A long semilunar incision was made in the scalp, from the forehead near the temple backwards to the mid-parietal regions, its convexity being upwards. A small trephine-opening was made at the summit of this incision, and, with this as a centre, a groove was chiselled in the bone, first downwards and forwards, then downwards and backwards. Thus, an omega-shaped groove in the skull was cut. The bone was then gently prised up, the short limb of the omega between its ends being broken. Thus a bony flap with scalp attached was raised about an inch away from the dura. The dura was not opened. The wound was dressed so as not to make pressure on this flap. The operation was followed by some improvement, but later information is much needed on this point.

Dr. Griffiths (*loc. supra cit.*) and others have established artificial lambdoid sutures, operating at intervals, first on one side of the skull and then on the other.

If any operation be performed, it should be strictly limited to linear

* De Vilbiss's forceps (p. 371) would be very useful here.

craniectomies, completed as speedily as may be, and performed in two stages. Every precaution should be taken against shock, and if the hæmorrhage has been severe it may be useful to resort to infusion of saline fluid (p. 140).

Dangers of the Operation.—These are chiefly—(1) Shock. (2) Hæmorrhage. Hæmorrhage from the scalp may be met by drainage-tubing passed around the head (p. 237), but other bleeding may be met with.

Dr. Shaw and Dr. Dendy, of Aylesbury, published with full detail (*Lancet*, vol. ii. 1895, p. 1423) a case of linear craniectomy which is instructive on this point. At the time of the operation on the right side, when the strips of bone had been removed, the dura mater did not give much evidence of tension. When, however, a month later the left side was operated upon, there was no doubt about fluid existing beneath the dura. A puncture was followed by a jet of blood. Exploration showed that the greater part of the left hemisphere was occupied by a huge blood-cyst. Marked collapse followed, and the child died five hours after the operation.

(3) Injury to the dura mater, especially adherent, in children. (4) Infective changes in the wound; these patients, restless and ill-regulated in their behaviour, may make the maintenance of asepis very difficult, especially in older and thus less easily managed cases, by tearing off their bandages. (5) Hyperpyrexia of obscure origin (p. 381).

TREPHINING IN GENERAL PARALYSIS OF THE INSANE, AND IN OTHER FORMS OF INSANITY.

As this operation has been recommended on the authority of Dr. Clay Shaw (*Brit. Med. Journ.*, vol. ii. 1889, p. 1090; vol. ii. 1891, p. 581) and Dr. J. Batty Tuke (*ibid.*, vol. i. 1890, p. 8) it deserves mention here; but time alone will show whether I am right in saying that it does not appear one to deserve encouragement, even as a palliative step. It must not be forgotten that here is no morbid condition which can be cured; that the excess of fluid—the removal of which, and so the relief of tension, is the object of trephining—is variable; and while it is clear that the benefit given by the operation has been only temporary, it must be remembered, as pointed out by Dr. J. Adam (*Brit. Med. Journ.*, vol. ii. 1889, p. 1187) and Dr. R. Percy Smith (*ibid.*, vol. i. 1890, p. 11), that temporary periods of spontaneous marked improvement are not uncommon. The operation promises to give most relief where marked headache or convulsive seizures are present and are not relieved by other treatment. Where the disease is advanced, and where the history of alcoholism is marked, the step should not be entertained.

It is interesting for surgeons to note that at the debate on Intracranial Surgery at Edinburgh in 1894 (*Trans. Edin. Med.-Chir. Soc.*, vol. xiii. p. 153), such authorities as Dr. Batty Tuke and Dr. Clouston were at distinct variance both as to the pathology and the operative treatment of this disease.

Dr. Tuke held that excess of fluid was certainly present. "In the cases in which he had recommended drainage by operative measures, obvious indications of pressure had been present, for when the disc of bone was removed the dura bulged much further into the

hole than was observed in traumatic cases where trephining was performed for the relief of local pressure. In all the seven cases he had seen operated on, a layer of fluid was distinctly noticeable existing between the arachno-pia and the true pia, varying in different cases, but always detectable by the finger." In all the seven cases immediate relief was obtained, and was maintained as long as the drainage, which should be slow and gradual, was continued.

Dr. Clouston, on the other hand, said that "from his views of the essential nature of the disease, and looking to its pathology and the course of all recorded cases, he was most sceptical as to any possible cure from any kind of operation whatever. He did not agree that the two cases reported by Dr. Claye Shaw and Dr. Batty Tuke were in reality cures, even if they were cases of general paralysis at all. In the diagnosis of early general paralysis they were all apt to make mistakes. With regard to the improvements recorded after operations, he did not think they were any more decided than they saw in ordinary cases of paralysis that were left to themselves. They saw such short improvements in a great many cases. He was absolutely sceptical as to the existence of general pressure at all in general paralysis. As regards the contested question as to whether the fluid under the arachnoid meant pressure or not, he held that it meant want of pressure, and was merely compensatory after the brain had undergone atrophy."

Until authorities of special experience in this disease can agree on its pathology, and especially on points of such practical importance as the presence of fluid, the part which this plays in the disease, whether it is primary or secondary, &c., the thoughtful surgeon will hold his hand.

Operation.—In the few cases recorded the trephine has been applied in the parietal region. Defined headache may help to localise its application. The dura mater should be opened and removed sufficiently to allow of free escape of fluid, and the pia mater, if œdematous, may be punctured. Drainage should be provided by horsehair or a tube, if needed. Dr. Claye Shaw has advised (*Brit. Med. Journ.*, vol. ii. 1891, p. 583) tapping and draining the lateral ventricles. This step is described below. It would certainly be difficult to keep up drainage for any useful period in many of these patients, and the histories of general paralysis of the insane do not suggest the existence of much intracranial pressure such as surgeons are familiar with in hydrocephalus. In conclusion, while I should add that I have no personal experience of the operation, it does not seem to me to be one based on sound pathological evidence, or justified by success.

As the question of trephining occasionally arises in *traumatic insanity*, I shall quote from Da Costa's incisive remarks as to the principles which should guide us (*Journal of Nervous and Mental Diseases*, June, 1904). Having condemned operation in cases of non-traumatic insanities, hypochondriacal delusions and hallucinations, Da Costa divides cases of traumatic insanity into two classes. To the first belong those cases in which the injury has caused no gross lesion and in which, on account of trivial shock, mental or physical, the patient has developed a distinct neurosis, on the basis of which a psychosis has supervened. In this group operation is not to be thought of. In the second group are found cases in which the injury is the direct and sufficient exciting cause of the condition. Here the insanity may develop at once or some time after the injury. Whether the insanity follows soon or later, the chief indications are depression of bone, local tenderness, fixed headache, or some localising symptom. When there are positive signs of increased pressure, trephining as a palliative measure may be considered proper. "One should not operate upon a case simply because there is word of an

antecedent fall or blow, which merely suggests the possibility of a traumatic origin for the insanity." Da Costa believes that injury is the direct cause of insanity in only 2 per cent. of the cases.

TREPHINING FOR DRAINAGE OF THE VENTRICLES.

It is well known that distension of the ventricles with a fluid largely cerebro-spinal does occur, causing symptoms closely similar to those of cerebral growth. It is natural, therefore, as treatment by medicine is useless, that surgery should be resorted to. Unfortunately, in the majority of the cases, the distension of the ventricles is only secondary to some disease in the cerebellum, corpora quadrigemina, or crura cerebri, pressing on the veins of Galen, or, as Mr. Hilton showed long ago,* to occlusion of the cerebro-spinal opening in the fourth ventricle—all forms of disease equally hopeless. In a few cases the collection of fluid is due to meningitis, tubercular or syphilitic. Mr. Stiles (*Edin. Hosp. Rep.*, vol. iv. 1896) considers that the balance of evidence is in favour of hydrocephalus being dependant upon an arrest of development of the brain. If this view be confirmed, the lack of success in treatment is accounted for. Every operating surgeon of any experience has tapped the ventricles through a lateral angle of the anterior fontanelle, with the result of often giving marked relief, obviously, from the nature of the cause, only temporary, convulsions and coma carrying off the patient after a varying interval. Modern surgery has not aided us here, owing to the conditions at the root of the mischief; withdrawal of the fluid slowly by a Southey's tube has been equally unsuccessful.

With a view of ensuring more gradual drainage and some alteration in the lining membrane, the following operations have been performed:

Trephining for Drainage of the Lateral Ventricles.—Prof. Keen, of Philadelphia, was the first to formulate the operation of trephining and puncture of the lateral ventricles, as distinguished from the ordinary puncture, which had long been done, in hydrocephalus (*Med. News*, Dec. 1, 1888; Mar. 9, 1889; Sept. 20, 1890).

In one case the patient was a boy, aged 4, with hydrocephalus and rapidly developing blindness, due, as proved later, to a growth of the cerebellum pressing on the straight sinus. The left ventricle was reached by trephining at a spot $1\frac{1}{4}$ inch above and behind the auditory meatus† and by puncturing the brain with a needle directed towards a point $2\frac{1}{4}$ inches above the opposite meatus. At a depth of about $1\frac{1}{2}$ inch resistance to the needle suddenly ceased, and cerebro-spinal fluid escaped. Three double horsehairs were then introduced and the needle withdrawn. Drainage thus established was kept up for fourteen days, when the horsehair was replaced by a drainage-tube.‡ On the twenty-eighth day after the operation, the symptoms returning, a corresponding operation was performed upon the right side and a drainage-tube passed directly into the ventricle. The child died on the forty-fifth day.

The second and third cases died four days and four hours respectively after the tapping.

* *Rest and Pain*, lectures ii. and iii. Mr. Hilton first noted this fact in 1844.

† Some consider this spot too near to the lateral sinus, and advise placing the trephine half an inch higher.

‡ This is best introduced by means of a Lister's sinus-forceps.

In the second the operation was just like that in the first, but as, on replacing the horse-hair drain by a tube, the escape of fluid appeared to be too free, the tube on each side was plugged. Then convulsions set in, and it being concluded that too much fluid had escaped, warm water was allowed to run into the ventricle. This was done repeatedly, the introduction of an ounce of warm water each time arresting the convulsions; but the child soon died.

Mr. Mayo Robson (*Brit. Med. Journ.*, 1890, vol. ii. p. 1292) was more successful, but it will be seen that his case differs widely from those in which fluid usually collects in the ventricles.

The case was probably one of meningitis, localised to the left posterior and middle fossæ, with otitis media of the left ear. Right hemiplegia supervened, and, in the hope of finding an abscess, the skull was trephined over the situation of the motor centre for the arm. An exploring needle failing to find pus, the needle was pushed into the lateral ventricle, withdrawing six drachms of clear fluid, on which pulsation returned in the brain. The hemiplegia gradually disappeared, and six months later the child was well, save for occasional recurrence of slight convulsive seizures limited to the right arm.

As will be seen at once, this case is totally different from the cases which usually call for tapping and drainage of the lateral ventricles. Thus, in this case, but one ventricle was affected, the surroundings were much more healthy, and there was no general internal compression of the brain.

The only case which recovered from the operation is one of Broca's (*Rev. de Chir.*, Jan. 1891), but the date at which the report breaks off makes it of very little value.

The patient, aged 4, was an imbecile suffering from hydrocephalus, and a contraction of the upper extremity, which had followed on convulsions. The skull was trephined at the spot chosen by Prof. Keen, and sixty grammes of fluid withdrawn. A drainage-tube passed through the cannula was allowed to drain into the gauze dressings, which were changed every day or two. On the sixteenth day very marked improvement was noted, the contraction in the right upper extremity having disappeared. The fluid gradually ceased to drain away, and by the fiftieth day the wound had entirely healed, and the child was discharged very much improved physically and mentally.

An interesting case in which tapping, not drainage, was successfully performed during exploration of the brain for obscure pressure symptoms, five months after an injury, is related by Dr. J. H. Nicholl of Glasgow (*Lan.* Oct. 29, 1898, p. 1114).

INTRACRANIAL DRAINAGE OF THE LATERAL VENTRICLES BY MAKING A PERMANENT COMMUNICATION BETWEEN THE VENTRICLES AND THE SUBDURAL SPACE.

An ingenious method of intracranial drainage in chronic hydrocephalus was brought before the Clinical Society by Dr. Sutherland and Mr. Watson Cheyne (*Trans.*, vol. xxxi. p. 166). Other modes of drainage having proved unsatisfactory, the following operation, based on the experiments of Dr. Leonard Hill (*Physiology and Pathology of the Cerebral Circulation*, 1896), was performed with a view of establishing a permanent communication between the ventricles and the sub-dural space.

The child, æt. 6 months, was markedly hydrocephalic, emaciated, anæmic, with intelligence practically undeveloped, and

The hydrocephalus and the basal

meningitis, which proved fatal, were attributed to congenital syphilis. A curved incision, about an inch and a half long, having been made over the left lower angle of the anterior fontanelle, the skin and deeper tissues were turned down from off the dura mater. A small incision was then made in the dura mater. To form a drain, a bundle of the finest catgut, containing some sixteen strands, and about two inches long, had been prepared, one end being tied together and the other being free. As soon as the dura mater was incised, the tied end of this bundle was pushed by means of sinus-forceps downwards and backwards, between the brain and dura mater, for about an inch. The other end of the drain, which projected through the slit in the dura mater, was then pushed by means of the sinus-forceps through the substance of the brain (very thin at this spot) into the expanded lateral ventricle. Clear fluid, about an ounce in amount, escaped. One end of the drain being thus left in the sub-dural space, and the other in the ventricle, the opening in the dura mater was closed with three fine sutures, and that in the skin by a continuous silk suture. By this step any risk of persistent oozing of the cerebro-spinal fluid, and sepsis, was avoided. On the fifth day, when the wound was healed, it was noticed that the head was distinctly smaller in all its dimensions. This diminution in size continued, but without any improvement as regards the child's intelligence or vision. Symptoms of basal meningitis began to appear nine weeks after the operation, and death followed three weeks later. The necropsy showed the opening into the left ventricle made at the operation, and an absence of inflammation around the remains of the catgut drain. While the lateral ventricles were not distended with fluid, a considerable quantity of fluid remained in the sub-dural space. Extension of the brain, the factor necessary for the removal of the intracranial fluid, had not taken place.

Mr. Morton relates a case of drainage of the ventricle into the sub-dural space. He points out that, though a communication existed for about two months, the hydrocephalus continued to increase.

The patient, aged 7 months, suffered from congenital and increasing hydrocephalus. A flap $\frac{3}{4}$ inch wide at its base was turned down over one angle of the anterior fontanelle between the right frontal and parietal bones. When the membranous skull and dura mater were turned back the brain at once bulged out. A piece of fine rubber tubing was then inserted with one end thrust through the thin cortex into the ventricle, and the other between the dura mater and cortex. It was secured to the dura by a silk suture. During the operation the baby was wrapped in cotton wool, and there was little or no shock. As a result of the operation, the edges of the cranial bones became prominent, with a tendency to override. A slight leaking of cerebro-spinal fluid took place for twenty-four hours. By the eleventh day the head was again enlarging, and, six weeks after the operation the circumference was $1\frac{1}{2}$ inches greater than before the operation. Mr. Morton, thinking that the tube might have become kinked, now operated on the left side. A rectangular metal tube, as used by Mr. Ballance, was inserted beside the rubber one, both being secured to the dura by sutures. There was again little or no shock. Considerable leakage occurred into the dressings for the first few days. Ten days after the operation there only remained a pin-point aperture, from which cerebro-spinal fluid leaked. The temperature ran up to 105° . The same evening the child died.

The necropsy showed that the brain had retracted one inch from the skull. The tube on the right side was in place and patent. Here the brain was adherent to the skull. Both tubes were in the ventricle, but the other end of the rubber tube was buried in the brain substance. The foramen of Munro was much enlarged.

I have performed Mr. Watson Cheyne's operation in three cases. In the first the onset of the hydrocephalus supervened on the cure of a spina bifida with Morton's fluid. The child lived eight weeks after the operation. In the other two there was no spina bifida. In one the child—decalcified bone tubes were used—lived five weeks. In the third I attempted too much. I drained both sides at the same time, and the child died a few hours later. In the two cases which survived the operation the shrinking of the skull and overlapping of the bones

was marked, but there was no evidence of any power of expansion on the part of the brain, nor of any attempt at restoration of an equilibrium between secretion and absorption of the fluid. And when one considers the local condition and the resulting vitality of these little patients, it appears to me extremely doubtful if any operation can be really successful. Though the greater part of the fluid be removed drainage of the very lowest layers is impossible. Here it can only be removed by absorption. Thus we have the fourth ventricle still dilated, the circulation through it, the medulla and the pons and the adjacent vital nerve roots all disarranged, and resulting in a very low state of vitality of these parts, and therefore of necessity of the patient also.

The following remarks by Mr. Watson Cheyne explain the *rationale* of the operation, and in part the cause of its failure. The conclusions drawn by Mr. Leonard Hill, especially that which shows that "fluid escapes directly into the veins from the sub-dural and sub-arachnoid space at any pressure above the venous pressure," suggested the line of treatment which has just been described. "If we could only establish a permanent communication between the ventricles and the sub-arachnoid space, then, no matter how much fluid was poured out into the ventricles, it would be at once carried off by the veins, and thus all injurious pressure, whether intra- or extra-cerebral, would be removed, and the brain would be free to develop if it could. And further, by this means matters would regulate themselves in a way that no method of external drainage could effect, for when the communication was once established the rest could be left to nature. The result of the operation fully confirmed these expectations. The disappearance of all abnormal intracranial pressure was complete and permanent from the time of the operation. The shrinking in the size of the skull was steadily progressive until a point was reached when the bones were overriding, and further diminution in the capacity of the cranium was checked. The factor necessary for the complete removal of the intracranial fluid, namely, the expansion of the brain substance, was apparently absent in this case, and the result was, that though the ventricles were completely drained, a considerable quantity of fluid remained in the sub-dural space, as shown at the necropsy; but, as there was no increased tension, it was not the presence of this fluid which hindered the expansion of the brain."

If any operation can succeed, it is the ingenious one of Dr. Leonard Hill and Mr. Watson Cheyne. I have not thought it worth while to take up my readers' time or to occupy my space with any other methods such as lumbar puncture or drainage from the lower spinal sub-arachnoid space into the peritoneal sac, or the introduction of sterilised air to take the place of the fluid removed by a Southey's tube (Dr. Ewart and Dr. Dickinson, *Pediatrics*, 1901, p. 277).

Drainage of the Fourth Ventricle.—This was performed by Mr. Stiles in a case of acquired hydrocephalus due to basal meningitis (Bruce and Stiles, *Trans. Edin. Med.-Chir. Soc.*, 1898, vol. xvii. p. 73).

The patient, æt. 13, with well-marked evidence of congenital syphilis, presented symptoms of chronic basal meningitis—viz., irregular pyrexia, persistent head-retraction, nystagmus, gradually increasing blindness, great weakness and emaciation. This condition becomi

critical, with marked cyanosis and rigors, it was decided to open the fourth ventricle and drain the ventricular system. Mr. Stiles trephined in the middle line over the lower part of the occipital bone, including the margin of the foramen magnum, and enlarged the opening by forceps. The dura mater was opened after the occipital sinus had been secured between two ligatures. Separation of the two tonsils of the cerebellum allowed of the escape of much cerebro-spinal fluid. Immediate improvement followed the operation, and lasted for a week, when there was again a rise of temperature. Death occurred, with hyperpyrexia, nineteen days after the operation, much cerebro-spinal fluid having drained away in this interval.

CHAPTER IV.

OPERATIONS ON THE FACE.

OPERATIONS ON THE FIFTH NERVE.*

Preliminary Remarks.—As the surgeon will not be called in until all other treatment has failed, and as the patient will be desirous of relief as radical as may be, neurectomy alone will be described here. *Operations* with this end fall into *Peripheral* and *Central* groups. Of the former or extracranial operations, some, the truly peripheral, are slight; others, performed near the base of the skull, are severe, not without risk, and leave considerable scars, which may greatly interfere with the use of the mandible. The central intracranial or removal of the Gasserian ganglion is a severe and difficult operation, with many risks and a mortality that is not a small one, but it is the only one which can be relied upon to give, with very few exceptions, a complete cure. It is greatly to be desired that both the peripheral and central operations be performed at an earlier date than has hitherto been done. In the case of the former the earlier the operation the greater the probability that the neuralgia is limited to one trunk, and the longer will be the interval of relief. In the case of the intracranial operations the still high mortality is largely due to the depressed vitality of the patients from the long continued inability to take food, the exhausting effects of the pain, the inability to sleep, and, perhaps, the morphia habit.

I will suppose that all local causes connected with the teeth, nose, eye, ear, and cranial sinuses have been excluded, together with those such as growths or foreign bodies in the course of the nerves, and that medical treatment has been fully tried where syphilis, alcohol, influenza, rheumatism, anæmia, etc., are possible causes.†

The first question which will now arise is the value of peripheral operations, to what extent are they justifiable in severe trigeminal neuralgia? To begin with, the answer must be that all mere neurotomies and nerve stretchings are absolutely futile. Radical lasting cures by peripheral neurectomies are practically unknown.‡ All that can be promised is that, if performed with as thorough extraction as

* For a more detailed account of these and all operations on nerves, I would refer my readers to M. Chipault's *Chir. Opér. du Système Nerveux*, tt. i. et ii., Paris, 1895.

† The pathology of tic douloureux is fully discussed by Mr. J. Hutchinson, Jr. (*The Surgical Treatment of Facial Neuralgia*, p. 26) and Murphy and Neff (*Journ. Amer. Med. Assoc.*, Oct. 11 and 18, 1902).

‡ Prof. Billroth, who had performed peripheral operations thirty times, stated never met with permanent cure.

possible of the peripheral branches,* they will give relief for varying periods. Hitherto the majority of authorities have held that peripheral operations should be performed first, intracranial neurectomy being taken as the last step. Thus Prof. Keen considers that this is the right step to take, and on these grounds, (1) the balance of evidence points to the ganglion itself being the last of all to suffer, the disease being in many cases at least primarily peripheral, and the ganglion involved by extension upwards. This view of an ascending neuritis has the support of Sir V. Horsley, who holds that the inflammation often begins in the small dental nerves, and spreads upwards to the ganglion.† (2) While the mortality of peripheral operations which usually relieve for some time is very slight, that following on operations on the ganglion is high (p. 413).

Mr. J. Hutchinson, Jr., whose successful experience enables him to speak as an authority, tabulates the following *rules for the use of peripheral operations in epileptiform neuralgia* (*loc. supra cit.*, p. 74). With regard to the first division of the fifth, a case may now and then arise in which resection of this nerve is justified. "If the neuralgia be limited to the infraorbital branches, resection of the nerve by following back the canal in the orbital floor may be tried. If the neuralgia concern also the palatine branches, intracranial resection of the superior maxillary trunk should be carried out. If the inferior dental nerve be alone affected, it should be resected through a trephine aperture in the outer table of the lower jaw. When the neuralgia concerns several branches of the inferior maxillary division (*e.g.*, the inferior dental and the auriculo-temporal), intracranial resection of the trunk and adjacent part of the Gasserian ganglion is indicated.

"For all other cases, those in which the neuralgia has already invaded two of the main divisions of the fifth nerve, the major operation on the ganglion should be carried out as affording the only hope of permanent cure.

"If these rules be followed the subject is rendered simple, a host of elaborate operations may be discarded, and the disappointing results which have followed them in the past may be avoided."

* Prof. Krause (v. Bergmann's "Syst. Prac. Surg.," *Amer. Trans.*, vol. i., p. 565) insists that in order to prevent regeneration of the excited nerve it should be extracted as extensively as possible, both centrally and peripherally, by Thiersch's method. This consists in dissecting the nerve freely from its surroundings, grasping it transversely in forceps which will not cut it through, then rotating these very slowly until the nerve trunk comes away. Where the nerve runs in soft parts or is not adherent in a bony canal a very long piece of the central portion can be removed. Occasionally paralysis, especially of the muscles of the upper lip and alar nasi, follow the operation owing to the endings of the anastomosing filaments of the facial nerve being also removed. These paralyses generally disappear in a short time. In all peripheral nerve operations the neuralgic pains do not always disappear immediately. They frequently come on as before during the first days after the operation, but they soon diminish and finally disappear. The attention of the patient should be drawn to this fact before the operation. On the value of this step the experience of Mr. J. Hutchinson, Jr., *The Surgical Treatment of Trigeminal Neuralgia*, p. 43, is contradictory. "Unfortunately the results obtained by avulsion with Thiersch's forceps are little, if at all, superior to a well-planned neurectomy."

† Mr. J. Hutchinson, Jr. from the negative results found in many cases of the excised Gasserian ganglion and peripheral nerves after removal dissents from this view. He considers that "the pathology of epileptiform neuralgia is still unknown."

Neurectomy of the First Division of the Fifth Nerve.

—The eyebrow having been shaved and the parts sterilised, the incision should be horizontal and lie below the margin of the eyebrow, thus leaving little scar. The supra-orbital notch* being made out by firm pressure when the patient is under an anæsthetic, the eyebrow is drawn up and the eyelid down, and an incision $1\frac{1}{2}$ inch long is made along the supra-orbital margin, with its centre opposite to the notch. The skin, occipito-frontalis, orbicularis, and palpebral ligament being divided, the cellular tissue is separated, the nerve found in the notch, set free—if a complete foramen be present, part of the ring of bone must be removed with a small chisel—traced back as far as possible so as to include the supra-trochlear if that be feasible, drawn up with a strabismus hook, and a full inch removed. Thiersch's method, if employed here, might involve some risk to the cornea.

A small copper spatula will best depress the orbital fat. It is difficult to avoid injury to the closely contiguous supra-orbital vessels, which may cause a little trouble. As with the other branches of the fifth, the supra-orbital often appears smaller than it does in the dissecting-room, and the arrangement of its branches is not constant. The wound should be closed by a few horsehair sutures.

Supra-trochlear Nerve.—In an inveterate case of neuralgia of the first division of the fifth nerve, if the surgeon does not feel sure that he has in the preceding operation got behind the point of origin of the supra-trochlear, this nerve must be cut down upon. Sir W. MacCormac (*Operations*, part ii. p. 467) gives the following advice: "The position of the supra-trochlear nerve is indicated by an imaginary line drawn from the outer angle of the mouth through the inner canthus of the eye to the orbital margin; at this point the nerve will be found as a single branch, or as two or three slender filaments, escaping from the orbit above the pulley of the superior oblique. . . . To reach the nerve, make a convex incision at the superior internal angle of the orbit, immediately below the eyebrow, and search for the pulley of the superior oblique, above which the nerve runs."

Neurectomy of the Second Division of the Fifth Nerve.

—While this nerve, being most frequently the seat of neuralgia, has been most often subjected to peripheral neurectomy, there is no agreement as to the best route. The following have been proposed. Each has its advocates, and each its disadvantages.

A. Infraorbital Route.—An attempt is here made to follow the nerve along the infraorbital groove as far back as the sphenomaxillary fossa. The *disadvantages* are great. The field of operation is very cramped, the oozing troublesome, and the operator is liable to divide the soft and comparatively slender nerve prematurely and to remove part only with the anterior dental branch, and hæmorrhage into the orbit and exomphalos have followed this operation.

* "The supra-orbital notch or foramen occupies about the junction of the inner with the middle third of the supra-orbital margin. From this point a perpendicular line, drawn with a slight inclination outwards, so as to cross the interval between the two bicuspid teeth in both jaws, passes over the infra-orbital and the mental foramina. The direction of these two lower foramina looks towards the angle of the nose."—Mr. Holden, *Landmarks Medical and Surgical*, p. 6.

B. Antral Route.—Either the modified Carnochan's operation or that which bears Prof. Kocher's name. The first is described below, and the second at p. 402.

C. Pterygomaxillary Route.—Krause's operation. The nerve is here reached in the sphenomaxillary fossa, not from the front, but at the side by turning down the zygoma and masseter. Prof. Krause, finding that the flap made by previous surgeons, Lücke, Lössen, and Braun, injured the branches to the orbicularis, and thus led to damage of the cornea, modified the operation so as to protect the branches of the facial running over the malar bone. The *advantages* of this route are that it enables the surgeon to get at the nerve before this has given off its posterior dental and palatine branches, and to resect the third division as well, if this be affected. The *disadvantages* are that, even if the wound heals by primary union the troubles of the patient and surgeon are not over; they are best shown by Prof. Krause's own words (*v. Bergmann's "Syst. Pract. Surg.," Amer. Trans., vol. i. p. 583*): "As soon as cicatricial contraction sets in, the mobility of the lower jaw is impeded in many cases. This may reach a very high degree, and will require careful treatment with Heister's mouth-gag." As the second division of the fifth nerve is often affected alone, and as it is to be hoped that in future cases will apply for surgical treatment earlier, before the palatine and posterior dental nerves are involved, two operations will be described here, viz., the modified Carnochan's antral operation and that of Prof. Kocher. Where the patient comes late and the second division is involved far back, or where the third division is involved as well, the surgeon must decide between adopting the pterygomaxillary route and resecting the two divisions by an intracranial operation as strongly advised by Mr. J. Hutchinson, junr., on the grounds that this step is no more difficult, while it is certainly far more radical.

Modified Carnochan's Operation.—This has the advantage, if successfully performed, of removing the whole of the second division of the fifth, together with the spheno-palatine ganglion as far back as the foramen rotundum, the nerve forming the guide to the surgeon from the surface backwards.

Carnochan (*Amer. Journ. Med. Sci.*, 1858, p. 136) looked upon the removal of Meckel's ganglion as the key of the operation. While his view was that this body could be likened to a galvanic battery, keeping up a continuous supply of "morbid nervous sensibility," there is no doubt that removal of the nerve *beyond* the ganglion is absolutely necessary, as by this step the spheno-palatine branches to the gums and the posterior dental branch are also removed (*Chavasse, Med.-Chir. Trans.*, vol. lxvii. p. 151, and Clutton,* *St. Thomas's Hosp. Rep.*, vol. xv. p. 213).

Carnochan's antral operation is, for the reasons already given when

* In both of Mr. Chavasse's cases the commencement of the pain was invariably referred to the periphery of the posterior dental branches, and it appeared very doubtful if stretching would have had any effect on slender branches at some distance from the extension point. Both of these cases remained practically well two years and a year and a half respectively after the operation. Recurrence, "slight and relieved by quinine," ensued in both of Mr. Clutton's cases within the year.

the infraorbital route was spoken of (p. 399), an extremely difficult one. Owing to these difficulties it is very often rendered incomplete, and the neuralgia tends to return after an interval varying from a few months to a year or two. Mr. J. Hutchinson, jun., who, having had the opportunity of assisting Sir. F. Treves at several of his operations, speaks with authority, considers that this operation should be abandoned (*loc. supra cit.*, p. 65). He holds that if any extracranial operation on the superior maxillary nerve be performed, the best one is that of Storrs, described by Dr. Cooke, *Ann. Surg.*, 1903, p. 854. It is stated that Dr. Storrs operated on some ten or twelve patients, and that of these at least two remained free from neuralgia for over ten years, an unusually favourable result for any form of peripheral operation.

As the antrum will be opened, the mouth and accessory cavities must possess at least the normal germicidal power of health. The parts having been shaved and cleansed and an anæsthetic given, a horizontal incision is made reaching from canthus to canthus just below the orbit, and a vertical one running downwards added if needful. The flaps thus marked out being reflected and all hæmorrhage stopped, the infraorbital nerve is defined, its terminal branches dissected out as long as possible, and a piece of silk tied round it to make it serve as a guide. The periosteum is next incised horizontally down to the bone, and elevated with a blunt instrument from the floor of the orbit until the sphenomaxillary fissure is well exposed. The eyeball must be raised with a retractor under the periosteum. A bluish spot usually denotes the site of the nerve, thinly covered by bone, or the canal is found by a fine probe passed in through the foramen.

With a fine chisel the anterior wall of the antrum, including the foramen, is cut away for a space of $\frac{1}{2}$ -inch square, and with the same instrument, aided by small and medium-sized bradawls, the roof of the antrum and its posterior wall—the latter for the same area as its anterior wall—are removed, so as to expose the sphenomaxillary fossa. Free and most troublesome hæmorrhage must be expected, partly from the vascular facial bone,* partly from the mucous membrane of the antrum, and in the fossa itself, where the bleeding is always copious, from the terminal branches of the internal maxillary. Pressure with small gauze pledgets, wrung out of very hot sterile saline or adrenalin solution in holders must be relied upon.

Bright daylight is essential, but an electric lamp on the surgeon's forehead will be his best aid.

The rest of the operation will be given from the article above quoted from the *Annals of Surgery*: "By making slight traction on the ligature on the nerve we can bring it into view, and by following it on can readily crush down the thin wall of the canal, removing the bone fragments with suitable forceps. When the nerve enters the sphenomaxillary fissure it passes out of the bony canal and is only surrounded by soft structures, which can easily be hooked or wiped away. Should the sphenomaxillary fissure be narrow and not readily admit the introduction of instruments, it can easily be widened by inserting a suitable blunt instrument, and by wedging or widening the walls. It is to be

* The superficial hæmorrhage will be all the freer in proportion as the part has been recently submitted to blistering, liniments, &c.

remembered that the upper wall of this fissure is the strong wing of the sphenoid, and that the lower angle is the thin wall of the antrum. If either bone should break it would be the wall of the antrum, which would be crushed down and out of the way and would cause no trouble. Having the nerve thus free to the foramen rotundum, next slip the ends of the silk through a loop of wire held with a small nasal snare. The loop of wire is passed down the nerve to the foramen rotundum. It is then closed, and the nerve is cut and removed."

To return now to the distal end of the nerve. The plexus of nerves going to the cheek, nose, and lip is gathered up with a hook, and the distal end drawn out of the foramen. Storrs then put the nerve into the loop of a threaded needle and carried it down into the mouth, leaving the end which had been in the infraorbital canal between the alveolus and upper lip; this end he cut off even with the mucous membrane. This was to prevent any restoration between the distal end of the nerve and the stump left at the foramen rotundum. Arrest of bleeding, drainage, and, if needful, packing the wound, and the sutures complete the operation.

Prof. Kocher's Antral Operation.—This surgeon, by dividing the malar bone in front and behind and turning it upwards and outwards, gains much freer access to the foramen rotundum (*Operative Surgery, Stiles's Trans.*, p. 93). The skin incision is planned so as to avoid division of the branches of the facial nerve. It begins just internal to the infraorbital foramen and below the inner edge of the orbital margin, and is carried outwards and slightly downwards over the lower part of the malar bone to the zygoma. The angular artery is drawn aside or tied at the inner end of the incision; Steno's duct lies below it. At its inner end the incision passes down to the bone between the lowest fibres of the orbicularis and above the origin of the levator labii. The former muscle, along with the periosteum, is dissected up as far as the orbit; the latter is separated downwards subperiosteally, so that the nerve may be exposed at the foramen and secured.

The outer part of the incision passes above the origin of the zygomatici, which are separated downwards, and the anterior fibres of the masseter are detached from the lower and inner aspect of the malar bone. The outer and inner surfaces of the malar bone are next laid bare with a periosteal elevator, and the three sutures—malo-maxillary, fronto-malar, and zygomatico-malar—are exposed previous to their being chiselled through. The malar process of the upper jaw must be exposed on its anterior surface up to the infraorbital foramen, and upon its upper surface as far back as the sphenomaxillary fissure. Anteriorly the process is chiselled through from above the infraorbital nerve downwards and outwards to just below the anterior fibres of the masseter, and superiorly along the orbital plate. In this way the outer part of the orbital plate and the superior external wall of the antrum, together with its hinder angle, remain in connection with the malar bone, and are levered out with it. Before this can be done the fronto-malar suture, exposed by upward retraction of the upper edge of the wound, is so chiselled through towards the back of the sphenomaxillary fissure that its upper border, together with part of the zygomatic crest and of the orbital plate of the sphenoid, is removed along with it.

The malar bone is dislocated upwards and outwards with a strong

hook, and the orbital fat carefully raised with a blunt retractor. The nerve which is kept drawn upon can now be readily followed above the opened-up antral cavity as far as the foramen rotundum. A small hook is now passed behind the descending sphenopalatine nerves around the main trunk, which is either cut across or removed by Thiersch's method. The infraorbital artery is avoided or tied. The operation is completed by replacing the malar bone (fixation sutures being unnecessary) and closing the wound with sutures. No bad results have followed the free opening of the antrum. The resulting scar is not disfiguring.

Operations on the Third Division of the Fifth Nerve.—I shall describe here neurectomy, first of the inferior dental, a nerve so commonly the seat of neuralgia; and then of the lingual gustatory, which is much less frequently affected.

Inferior Dental: Neurectomy.—This nerve may be attacked in three places—at the mental foramen, in the dental canal, and above the dental canal. Experience has shown that the relief after the first two methods is so transitory that the higher operation should always be resorted to. Neurectomy here usually gives relief for one, two, or more years. The face having been shaved and cleansed, the external meatus cleansed and plugged with aseptic wool, the patient is placed under an anæsthetic. The surgeon then identifies the point of bone to be aimed at on the ascending ramus by taking the meeting of the two following lines—one perpendicular to the lower border of the jaw passing upwards from its angle, and the other a continuation backwards of the alveolar margin (Hutchinson). This point on the cheek is well below the parotid duct and behind the facial vein. The skin incision here should be about one and a half inches long, mainly horizontal to avoid the facial nerve, but slightly curved upwards. Prof. Kocher's incision is a curved one, with the angle of the jaw for its centre.

The subjacent periosteum and masseter are separated from the bone, and the pin of a $\frac{3}{4}$ -inch trephine is then applied exactly over the spot above mentioned, and when the outer table has been cut through the crown is removed by an elevator. The inferior dental nerve and vessels will almost certainly be exposed in their groove. This is carefully enlarged by a small chisel or gouge, until the nerve, now freely exposed, can be raised on a blunt hook. It is then treated by Thiersch's method (p. 398), or as long a piece as possible, resected. Care must be taken to avoid injury to the vessels which lie just behind the nerve. Another method (Sir V. Horsley, *Brit. Med. Journ.*, vol. ii. 1891, p. 119; Mr. Rose, *ibid.*, vol. i. 1892, p. 160) is to expose the bone more freely and widen the sigmoid notch by a larger flap, to turn this upwards, and wrap it in sterilised gauze. The sigmoid notch and adjacent parts of the condyle and coronoid process are next laid bare. Care must have been taken not to injure any of the branches of the facial nerve or lobules of the parotid gland during the above steps. When the bone is reached, smart oozing must be expected from the masseteric artery, and arrested by firmly applied sponge-pressure. The next step consists in enlarging the sigmoid notch as far as the upper orifice of the dental canal. This is done by applying a $\frac{3}{4}$ -inch trephine exactly on the spot mentioned above, the narrow bridge of

bone between it and the sigmoid notch being subsequently clipped away with bone-forceps. Great care must be taken, owing to the varying thickness of the bone, in the use of the trephine; otherwise the inferior dental artery will be wounded or the bone fractured.* De Vilbiss's forceps (p. 371) will very likely be useful here. The bone having been removed sufficiently, some loose yellow fat usually comes into view, and, to avoid bleeding, the inferior dental and the internal maxillary, if this be in the way, should be secured between two ligatures. The inferior dental nerve is next identified and secured by a silk ligature. The external pterygoid having been levered upwards, or divided if needful, the nerve is followed close up to the foramen ovale, and divided as high up and as low down as possible, or dealt with by the method of Thiersch. If needful the lingual nerve, which lies somewhat anteriorly and on a deeper plane, is then treated in a similar way. Any venous bleeding which cannot be dealt with by ligature should be met by firm pressure with aseptic gauze. There is no need to replace any bone. The wound, carefully kept aseptic throughout, is now thoroughly dried, a small drainage-tube inserted if there be still much oozing or if the parts have been much disturbed, and the wound accurately united with horsehair sutures. If primary healing occurs there is no interference with the functions of the mandible.

Lingual Gustatory: Neurectomy within the Mouth.—In a few cases of epithelioma of the tongue, not admitting of removal, this operation may be performed in the hope of relieving the pain, and diminishing the rapidity of the growth, the profuseness of the fœtid dribbling saliva, &c. In another small group of cases, neuralgia of the tongue, resisting other treatment, this operation may be resorted to with entire success.

The best method is that of Roser, of Marburg, who introduced it in 1855, though it is known in France as the operation of Létievant (Chabot, *Chirurg. opérat.*, p. 134). The mouth having been widely opened in a good light, and the tongue drawn over to the opposite side, an incision is made in the fold of mucous membrane between the side of the tongue and the gum, the centre of the incision being opposite to the last molar tooth. The overlying mucous membrane is here so thin that the nerve can usually be seen below it. The nerve having been exposed where it lies beneath mucous membrane only, just before it dips beneath the myo-hyoid, is raised with an aneurysm-needle, and a full inch removed. The only after-treatment required is the frequent use of a mouth-wash.

I have performed this operation on two occasions. In one the patient remained absolutely free from her neuralgia for twelve months, after which there was some recurrence owing to her entire neglect to avail herself of the fresh air and rest which were so necessary in this case. The second patient remained free from the neuralgia for the six months during which I was able to keep her under observation.

* To avoid this last complication Sir V. Horsley advises first drilling the bone with a row of holes along the line of the part to be removed, and then cutting it out with curved bone-forceps (*loc. supra cit.*, p. 1193, Fig. 2).

Neurectomy of the Second and Third Divisions of the Fifth Nerve in front of the Ganglion inside the Skull.—Operations on the Gasserian Ganglion.

Peripheral operations on the second division of the Fifth Nerve in cases where the palatine and posterior dental branches are not yet involved, and one on the inferior dental and lingual gustatory in cases where these branches are alone affected, and the mischief has not spread to other branches, *e.g.*, the auriculo-temporal, have now been given. It remains to consider the operative treatment of cases in which either the second or third division of the fifth nerve is more deeply affected, cases in which peripheral operations have failed, and lastly those in which the neuralgia has already invaded two of the main divisions of the fifth nerve. Reference to p. 398 will show that Mr. J. Hutchinson, jun., is emphatic in his opinion that in these cases the operation should be intracranial, as this method alone gives radical relief. We have seen, moreover, that the extracranial routes which attack the nerves at their exit from the skull are followed by serious fixity of the jaw (p. 400).

The following is an instance in which Mr. Hutchinson put his opinion to the test by resecting the second division of the fifth intracranially (*Lan.*, vol. i. 1904, p. 1044; *Surg. Treat. of Facial Neuralgia*, p. 70).

The case was one of typical epileptiform neuralgia confined to the distribution of the second division, occurring in a robust patient of 60.

The cranial wall having been removed as described at p. 407, the dura mater and brain were then carefully pushed upwards and inwards, the foramen rotundum being aimed at as a landmark. Much difficulty was experienced in doing this owing to the thinness of the dura mater, and some cerebrospinal fluid escaped. The trunk of the second division and the ganglion were thoroughly exposed and the whole intracranial part of the nerve was removed, the nerve being divided close to the Gasserian ganglion and again at the foramen rotundum. A small drain was used, but no bone replaced. Primary healing followed, and for eighteen months the patient had not had the least return of his trouble.

Mr. Hutchinson considers this operation in every way superior to that of Carnochan, and where, as in this case, the second division is alone affected, removal of the Gasserian ganglion is unnecessary. He expresses himself as confident that no recurrence is likely to take place.

Operation on the Gasserian Ganglion.—This structure has been reached by two routes. i. **The extracranial.**—This method was brought into prominence by Mr. W. Rose, whose name it bears. By it the ganglion and the nerve trunks are reached by trephining at the base of the skull from without. ii. **The intracranial.**—Here the ganglion and nerve trunks are got at within the middle fossa, through the side of the skull. Hartley-Krause method (p. 406).

Of the above the first has been abandoned owing to the difficulties, the possible bad results which are given below, and the uncertainties of its results. It will therefore not be described here. While, as will be fully shown, the intracranial method is not without its own serious difficulties and dangers, it gives far better access, and its results are incomparably better.

Those who desire full details of the extracranial route will find them given by Mr. Rose, *Brit. Med. Journ.*, vol. i. 1892, p. 261. Reference

bone between it and the sigmoid notch being subsequently clipped away with bone-forceps. Great care must be taken, owing to the varying thickness of the bone, in the use of the trephine; otherwise the inferior dental artery will be wounded or the bone fractured.* De Vilbiss's forceps (p. 371) will very likely be useful here. The bone having been removed sufficiently, some loose yellow fat usually comes into view, and, to avoid bleeding, the inferior dental and the internal maxillary, if this be in the way, should be secured between two ligatures. The inferior dental nerve is next identified and secured by a silk ligature. The external pterygoid having been levered upwards, or divided if needful, the nerve is followed close up to the foramen ovale, and divided as high up and as low down as possible, or dealt with by the method of Thiersch. If needful the lingual nerve, which lies somewhat anteriorly and on a deeper plane, is then treated in a similar way. Any venous bleeding which cannot be dealt with by ligature should be met by firm pressure with aseptic gauze. There is no need to replace any bone. The wound, carefully kept aseptic throughout, is now thoroughly dried, a small drainage-tube inserted if there be still much oozing or if the parts have been much disturbed, and the wound accurately united with horsehair sutures. If primary healing occurs there is no interference with the functions of the mandible.

Lingual Gustatory: Neurectomy within the Mouth.—In a few cases of epithelioma of the tongue, not admitting of removal, this operation may be performed in the hope of relieving the pain, and diminishing the rapidity of the growth, the profuseness of the fœtid dribbling saliva, &c. In another small group of cases, neuralgia of the tongue, resisting other treatment, this operation may be resorted to with entire success.

The best method is that of Roser, of Marburg, who introduced it in 1855, though it is known in France as the operation of Létiévant (Chabot, *Chirurg. opérat.*, p. 134). The mouth having been widely opened in a good light, and the tongue drawn over to the opposite side, an incision is made in the fold of mucous membrane between the side of the tongue and the gum, the centre of the incision being opposite to the last molar tooth. The overlying mucous membrane is here so thin that the nerve can usually be seen below it. The nerve having been exposed where it lies beneath mucous membrane only, just before it dips beneath the myo-hyoid, is raised with an aneurysm-needle, and a full inch removed. The only after-treatment required is the frequent use of a mouth-wash.

I have performed this operation on two occasions. In one the patient remained absolutely free from her neuralgia for twelve months, after which there was some recurrence owing to her entire neglect to avail herself of the fresh air and rest which were so necessary in this case. The second patient remained free from the neuralgia for the six months during which I was able to keep her under observation.

* To avoid this last complication Sir V. Horsley advises first drilling the bone with a row of holes along the line of the part to be removed, and then cutting it out with curved bone-forceps (*loc. supra cit.*, p. 1193, Fig. 2).

to the *Practitioner*, 1899, p. 255, will show that Mr. Rose himself gave up his method and advocated extensive resection of, first, the superior maxillary, and, secondly (after an interval of a few weeks), of the inferior maxillary division.

The following are the chief difficulties and dangers of the extra-cranial route:—

(1) The very limited field in which the surgeon has to work in this, one of the most difficult operations of surgery. (2) **Hæmorrhage.** This, from the presence of the pterygoid plexus, is certain to be troublesome, and may be baffling. Even in Mr. Rose's experienced hands (*Lancet*, 1892, vol. i. pp. 71, 182, 295) this proved to be the case on two occasions; in one it is recorded that only the posterior half of the ganglion was removed, and the anæsthetic area was found later on to be mainly confined to the third division of the nerve; in the other case the dura mater and the Eustachian tube were injured, leading to infective fatal encephalitis. In the only case in which I have performed this operation the oozing not only from the pterygoid plexus but from other small veins through the foramen ovale and other small openings in the base of the skull was so persistent that the needful prolongation of the anæsthetic and operation necessitated deferring the completion of the operation. This was undertaken five days later, and I was able to resect the second and third divisions, the auriculo-temporal and buccal nerves, and what I believed to be the posterior half of the ganglion. This proved however not to have been the case. The pain returned, and the patient was later on operated upon with complete success by Mr. J. Hutchinson, jun., at the London Hospital, by the intracranial method. He informed me that my trephine-opening had just missed the ganglion. (3) Injury to the Eustachian tube. In one case there was free hæmorrhage from the nose and mouth during the operation. The necropsy, five days later, showed that injury to the Eustachian tube had led to infection of the wound and meningitis. (4) The division of bone required, viz., zygoma and coronoid process, has been followed by necrosis. (5) The fixity of the jaw and a disfiguring scar, the latter especially in women, are common sequelæ.

Operations on the Gasserian Ganglion by the intracranial route. The Hartley-Krause operation.—The following description is based upon Prof. Krause's article (v. Bergmann's "System of Surgery," *Amer. Trans.*, vol. i. p. 585), Mr. J. Hutchinson, jun. (*The Surgical Treatment of Facial Neuralgia*, p. 75), and the account given by Dr. Hartley, (*Annals of Surgery*, 1893, p. 509). As the operation, affording as it does the only complete cure of inveterate neuralgia of the epileptiform type, is likely to be increasingly performed, and as it is liable to be one of the most difficult in surgery, I have gone much into details, I trust helpful ones. *Preparatory treatment.*—As shock from a prolonged operation and hæmorrhage is a chief cause of death accounting in the published cases for nearly half the mortality, all the well known precautions must be taken before, during and after the operation. In the previous sterilisation of the field of operation the external auditory meatus should be cleansed and plugged with sterile gauze. Some writers advise paring and suture of the centre of the lids before the operation is begun. Prof. Krause does not recommend this step as it interferes with examination of the cornea, and because "healthy eyes in general

do not become inflamed after the Gasserian ganglion is removed."* He admits that the danger is greater if there is any suppuration about the lachrymal sac, or if earlier peripheral operations have interfered with closure of the lids by facial paralysis. Mr. Hutchinson considers this step not only irksome but needless, owing to the great rarity with which it is needful to interfere with the ophthalmic division, as this is so seldom the seat of neuralgia. He further points out that temporary closure of the lids affords no guarantee for the future safety of the cornea when the ophthalmic division has been divided.

Operation.—This may be divided into three stages. (1) *Opening the skull*; (2) *Finding the Ganglion*; (3) *Removing the Ganglion*.—The following especial instruments should be at hand, those named at p. 370 according as the surgeon will remove the bone or turn down an osteoplastic flap, a special broad flexible retractor (highly polished so as to reflect the light, at least 8 cm. long (Krause). An aneurysm needle with a short curve and smaller than usual or a flexible-eyed probe may be needed to tie the middle meningeal artery. Sharp and blunt-pointed tenotomy knives, fine-pointed blunt dissectors and elevators, an electric head-lamp, and a dentist's chair for raising the patient into the sitting position.

(1) *Opening the skull.*—Very little need be added here to the full directions given at p. 370. Here, also, the operator will be guided by his experience and the remarks made above as to whether he will remove the bone or perform an osteoplastic operation, and the means that he will adopt in either case. In addition to the points given at p. 367, which will aid the surgeon in his choice of method, two others may be given here. Mr. Hutchinson gives the following as a reason for preferring removal of bone in addition to the fact that the gap will be completely filled up. "The bone forming the temporal fossa is thin and deeply grooved in old subjects (and nearly all the patients are elderly), and in using Gigli's saw or chisel, &c., the dura mater is readily injured. Although in the late stage of the operation this sometimes cannot be avoided, and the escape of cerebro-spinal fluid even facilitates access to the ganglion, at an early stage it is undesirable." If the osteoplastic method is adopted, the words of Krause must be remembered. When the base of the flap is fractured, the fracture line runs about 1 cm. above the zygoma; the crest of bone which remains here and which interferes with the view is removed with gouge-forceps down to the base of the skull—that is, to the infra-temporal crest. It is absolutely necessary that the base of the skull be fully exposed and the dura down to the point where it turns in below. The flap should be well rounded, with its base at the zygoma and its upper edge two inches above this ridge. The two extremities of the incision should begin at the eminentia articularis behind and the malar bone in front. The bone to be removed is the front half of the squamous portion of the temporal. However made, the flap when raised is wrapped in sterile gauze. The position of the patient is important. Prof. Krause writes: "The patient is almost in a sitting posture, the head rests upon the occiput, and an assistant holds it as directed. In this position the blood and

* As will be seen later, Prof. Krause removes the entire ganglion.

the exuding cerebro-spinal fluid which would otherwise collect at the bottom of the funnel-shaped wound will flow out, and thus the view will not be so readily obstructed." This position also lessens the hæmorrhage. The brain, moreover, tends to fall back. Mr. Hutchinson has found that with due care the sitting position in a dentist's chair will not increase the difficulties of the anæsthetist. v. Bergmann, I believe, raises the patient into the sitting position when the skull has been opened.

(2) *Finding the Ganglion.*—Partly with a blunt raspatory or closed, curved, blunt-pointed scissors, partly with the finger, the surgeon now separates the dura mater very carefully from the base of the skull, working directly inwards towards the foramen and rotundum ovale, which lie at a depth of $1\frac{1}{4}$ inches from the wall of the temporal fossa. The foramen spinosum is, however, placed externally to as well as slightly behind the foramen ovale, and will therefore probably be reached first. Mr. Hutchinson has found that the eminentia articularis is a sufficient landmark for the two, being situated on the same vertical plane, 3 cm. external to and slightly below them.

The next steps will vary somewhat according as the middle meningeal is tied as a rule or not. It will be remembered that hæmorrhage of different kinds and from different sources is one of the chief difficulties, and the chief cause in prolonging an operation always difficult and usually performed in patients of poor vitality. Prof. Krause, who, writing in 1902, had an experience of 36 operations, recommends this precaution strongly. He allows that in cases where the foramen spinosum is situated exceptionally far behind the foramen ovale, this step may not be needful, "yet ligature and division are much safer and should be continued by all means." The dura mater having been separated and the foramen spinosum reached, the brain surrounded by the dura is now carefully raised by a right-angled retractor held by an assistant. This elevation should go no further than is absolutely necessary to obtain a clear view. By raising the dura with an elevator from the base of the skull internal to the artery so that the second and third divisions of the fifth nerve become visible, the artery with its two veins comes into view as a distinct strand running up to the dura from the foramen spinosum, and can be isolated on all sides and divided between two threads passed by the means mentioned above (p. 376). If the ligatures slip or owing to other cause cut through the vessel, Krause introduces a blunt right-angled hook into the foramen, presses it down tightly with a raspatory, and turns it to and fro until the bleeding stops, or leaves it in place. Ligature of the external or common carotid is not to be performed now or as a preliminary step, as has been recommended; in one case, which occurred in Philadelphia, death of the flap and fatal septicæmia followed. Mr. Hutchinson has found that while it is possible to remove the ganglion without ligature of the middle meningeal, its division between two ligatures undoubtedly facilitates the raising of the dura mater and exposure of the inferior maxillary nerve and the lower edge of the ganglion. With regard to ligature of the external carotid he considers that this procedure will affect the arterial bleeding very little owing to the free collateral circulation. He has only once taken this step, and in this case, the ligature being performed in the middle of the operation, no apparent effect was produced. "Keeping the patient in an upright

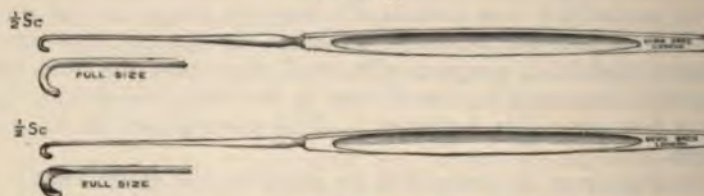
superior petrosal sinus. Great care should be exercised that none of the structures lying mesially, not even the smallest fold of dura mater, is caught in the tip of the forceps.

"The surgeon must now cut through the second and third branches with a sharp tenotome or small curved scissors close to the foramen wall and rotundum. The forceps which has grasped the ganglion can now be slowly rotated around its axis. The entire ganglion will always follow, and with it a larger or smaller piece of the posteriorly placed trigeminal trunk. The first branch generally tears off close to the ganglion, but since only peripheral portions of it remain, it is as good as gone.

"In conclusion the author presses the peripheral stumps of the second and third branch as deep as possible into the foramen rotundum and ovale with an elevator." (Krause).

Opinions differ as to the extent to which ganglion should be removed. Prof. Keen, like Prof. Krause, would remove the entire ganglion. He believes that the present methods of dealing with the eye are so

FIG. 144.



Rose's hooks, blunt and sharp, for isolating and dividing the trunks of the fifth nerve. (Down Bros.' Cat.)

improved that its preservation is ensured though the whole ganglion be removed. On this subject the remarks at p. 412 should be referred to. Secondly, any arbitrary line of removing the outer two-thirds and leaving the inner third will leave diseased ganglionic cells if the ganglion is affected. Any stimulus from the first division will excite sensation in these, and thus bring about a return of pain.*

Mr. Hutchinson, on the other hand, would limit the removal of the ganglion to its lower and outer part by the section shown in Fig. 145. The ganglion is exposed by removal of the outer layer of its sheath which is always closely adherent. When this exposure has been thoroughly effected, and not before, the superior and inferior divisions are cut cleanly across at their foramina with a tenotomy knife or the hook (Fig. 144). The ganglion being firmly held by toothed forceps is now divided so as to leave the ophthalmic division intact. This method which has given excellent results in his hands is based on the fact that the ophthalmic division is not often the seat of neuralgia. Mr. Hutchinson has not found a case in which by leaving the ophthalmic trunk neuralgia occurred in it. The advantages of the above method are "(1) There is no anæsthesia of the cornea, and, hence, no risk

* The comparative infrequency with which the ganglion is found diseased has been alluded to at p. 398.

of loss of the eye. (2) There should be no danger of injuring the oculomotor nerves, or the cavernous sinus. (3) The severity of the operation is rendered less, the hæmorrhage and the chance of injurious pressure on the brain being both materially diminished."

Closure of the Wound and After-Treatment.—In many cases as soon as the operation is finished and the brain allowed to settle down in its place the hæmorrhage ceases, or can be checked by temporary pressure. If serious bleeding continue the careful use of tampons must be trusted to. And here I would remind my readers that the temporo-sphenoidal lobe has frequently been found injured in necropsies

FIG. 145.



The cavernous sinus and Gasserian ganglion seen from above. P.B.—The petrous bone. C.A.—Carotid artery. iii., iv., and vi.—The oculomotor nerves, showing their relation to the ophthalmic division of the fifth nerve. The relative positions of the middle meningeal artery and the inferior maxillary nerve are shown. The dotted line crossing the Gasserian ganglion represents the section advised in removing the latter, together with the superior and inferior maxillary trunks. (J. Hutchinson, Jr.)

of fatal cases, and that a fertile source of such injury is the use of gauze during and at the close of the operation. During the operation the use of small pieces of gauze wrung out of sterilised adrenalin solution and careful shifting of the retractor will arrest venous oozing. That from the middle meningeal has been alluded to, p. 408. Bleeding from the cavernous sinus is to be interfered with the ophthalmic division and which it springs. Infective meningitis followed in several cases required to be treated by the use of the here.

Prof. Krause prefers to finish the operation in one sitting, even if it takes long owing to frequent interruptions due to the need of resorting to frequent packings: he only "resorts to the operation in two stages in the extremest cases. For he does not consider it without risk to expose patients exhausted by protracted severe pains twice within a short time to the dangers of narcosis and an operative procedure. Besides, the aseptic course is endangered if the deep wound remains open long, even if the flap is secured over the iodoform tampon with a few sutures. In general, the operation in one sitting where the bone was preserved, required one-and-a-half hours; with slight hæmorrhage he has frequently required only twenty to twenty-five minutes after the bone has been cut out of the skull." In estimating the meaning of "extremest cases" my readers will remember that Prof. Krause was speaking after operating on 36 cases. Those with necessarily very different experience will be wiser if, in spite of all precautions having to face the persistently severe hæmorrhage of which I have spoken and to which I shall refer again, they decide to meet the risks of deferring the completion of the operation rather than those of fatally exhausting their patient, or incompletely removing the ganglion because they cannot see it. But with the experience now before us such hæmorrhage should more rarely be met with. On the completion of the operation a medium-sized drainage tube is passed through the entire depth of the wound, between the dura and skull, and brought out at the posterior angle of the incision in the skin: where the osteoplastic method has been employed the bone must be notched here to allow the tube exit. Where the skull has been removed it is needless to put back bone. The tube should be removed in forty-eight hours. In those cases where the dura has been opened accidentally or intentionally in order to relieve the tension of the brain, the escape of cerebro-spinal fluid for the first few days may be such as to require daily change of the dressings.

The cornea will need careful attention. Those who suture the lids will divide the united portion in about two weeks, nothing stronger than boracic acid lotion having been used as a lotion in the interim, and afterwards large protective glasses should be constantly worn to prevent access of dust (Hutchinson). Prof. Krause, who, as we have seen, dispenses with suture of the lids, uses a Buller's eyeglass to be worn as long as any tendency to irritation remains. He advises that no bandage be employed to protect the cornea as it always exerts some pressure. In two cases where the facial nerve had been injured by previous operation he saw linear ulcers develop, which corresponded exactly to the edge of the upper lid. Mr. Hutchinson (*loc. supra cit.*, p. 110) states that if the ganglion be completely removed there will always remain some risk of trophic ulceration and the loss of the eye. In support of this he has collected ten cases. While the danger is greatest during the first few weeks, an anæsthetic cornea is never really safe. This risk can be avoided by excision of the ganglion in the manner described at p. 410.

Results of the Operation.—Prof. Keen, of Philadelphia, who in 1898 had operated by the intracranial method in fourteen cases (*On Resection of the Gasserian Ganglion, with a Pathological Report on the Ganglia by Prof. Spiller, 1898*), writes: "What has been the history of the cases

as to cure? So far as I know, there have been only four cases in which the pain has returned; one reported by Rose, one by Dana, and two by myself. But I especially desire to call attention to the fact that my own two cases of recurrence were my first two operations; that in Case I. no microscopical examination of the fragments was made, and in Case II. the examination revealed no ganglionic cells or nerve-fibres. Case I., as I now look at it, was imperfectly done, and Case II. still more so. Therefore the recurrence of pain in these two cases cannot be used as an argument against the removal of the ganglion. In addition to the above, Krause has reported one case in which the sensory root was found diseased, and the pain returned on the other side of the face. We can conclude, therefore, in general, as the result of experience in over 100 cases of intracranial operation, that, practically, the pain will not return in over 1 or 2 per cent. in any such severity as to liken it to the original disease, and that it will not return at all in more than 4 or 5 per cent." Dr. Tiffany, of Baltimore, who has afforded much help to surgeons in this matter by his article with a collection of 108 cases (*Trans. Amer. Surg. Assoc.*, 1896, p. 1), shows that while recurrence of pain may follow intracranial excision of branches of the fifth nerve close to the ganglion, recurrence has not been observed in those cases in which the ganglion itself has been known to be removed. "The place where the ganglion was supposed to be by the operator has been curetted, or pieces of tissue picked away with pincers, more or less in the dark: this does not constitute known removal; it does constitute attempted removal—a very different thing."

Prof. Krause, writing in 1902 with an experience of 36 cases, says that he has never seen a recurrence in any of his cases in which the ganglion was removed for typical trigeminal neuralgia, though nine years have elapsed since his first extirpation.

Mr. Hutchinson (*loc. supra cit.*, p. 125) writes that the cases in which recurrence of epileptiform neuralgia has followed *on the same side* as the operation may be put into two classes. "Either the patient was neurotic or hysterical (*i.e.*, not really a suitable subject for the operation), or the operation has failed to deal adequately with (perhaps has never even touched) the Gasserian ganglion." With regard to recurrence of the neuralgia *on the opposite side* this authority has only been able to find two or three instances amongst the records of several hundred cases.

Mortality of the Operation.—We have seen that Prof. Krause, writing very briefly, says that of his 36 cases, "3 died as an immediate result of the operation." Having collected 128 cases operated on up to the end of 1899 by the method he describes, Krause finds the mortality to be one of 15.6 per cent., 15 to 20 per cent. may be justly taken as the mortality of the operation except in specially skilled hands.* Here, from the special experience gained, the mortality of

* While this mortality is "partly deduced from cases which were still in an experimental stage" (Hutchinson) it is not to be remembered that the cases which have been published—many of them from Baltimore, in all

procedure while all must

the operation is much lower. Thus, Mr. Hutchinson writes, "Lexer's eleven and my own eight cases amount to nineteen without a single death. Sir V. Horsley kindly tells me that his personal experience has increased to approximately 120, with six deaths.* Taking his cases with Lexer's and my own, we have 140 cases with six deaths, only 4 per cent., and this includes two fatal cases which some surgeons might have left out."

Difficulties and Dangers of the Operation.—From the detailed account already given it will have been easy to estimate these. Perhaps the most striking testimony is that given by Prof. Keen, of Philadelphia, a surgeon well known for his wide operative experience, and particularly in cranial and cerebral surgery. Thus, in his paper quoted from above he writes: "Even now, after having operated on eleven, I always approach the operation with a certain amount of hesitation."

But while the Hartley-Krause operation will always remain one of the most difficult in surgery, and one from the gravity of its dangers not to be undertaken lightly, it has proved itself far superior to the extracranial method from the wider operation-field which it affords, the better access, and thus the far greater certainty of its results; and it may be confidently expected that by strict attention to the details of technique which we possess the mortality will now be lowered, especially if surgeons are able to operate on patients earlier, before their vitality is so much lowered, and if they avail themselves, when it is indicated (p. 412), of the two-stage method. To recapitulate the chief difficulties and dangers, the chief appear to be (1) Those met with in exposing the dura mater, these have been considered at p. 370. (2) Hæmorrhage. Several sources may be met with, (a) The diploe. (b) The middle meningeal artery. The methods of dealing with this have been fully given at p. 265 and 408. For the sake of justice to others and for that of completeness it is right to mention here that Harvey Cushing has recently advocated a method which he terms the *Direct Infra-arterial Method*. In making the temporal flap, and removing the bone, the incision does not go quite so high as in the Hartley-Krause method and Cushing removes the zygoma and detaches the temporal muscle and periosteum downwards with the object of fully exposing the infra-temporal crest, and thus making certain of exposing the middle meningeal artery low down under the anterior inferior angle of the parietal, when the skull is opened.

Mr. Hutchinson considers that in removal of the zygoma and in the opening of the skull low down, Cushing's method shows a reversion to Rose's operation, and that it is doubtful whether these slight modifications present any real gain. On the other hand, Prof. Kocher thinks so highly of the operation that he describes it and

p. 12) gives the mortality as 22 to 23 per cent. In the discussion which followed, Dr. Ranshoff, of Cincinnati, thought that if it were possible to obtain accounts of *all* the cases operated upon, the mortality would be nearer 50 per cent.

* "Of the six fatal cases, cerebral hæmorrhage was the cause in three; one patient died from septic infection (from a septic case in the same ward of the hospital). In the other two cases an interval of three or four months occurred after the operation, the cause of death being doubtful."

no other in the last edition of his *Operative Surgery* (Stiles's Trans., p. 98).

For want of space, and in the belief that the full details already given will suffice, I have not described it here. The original paper will be found in *The Trans. Coll. of Phys. of Philadelphia*, April, 1900, and *Journ. Amer. Med. Assoc.* April 28, 1900, p. 1035. Other sources of bleeding are (c) the small middle meningeal, especially the branch running under the ganglion; (d) the veins of the dura mater; (e) those of Santorini; (f) the cavernous sinus, and even (g) the internal carotid. Means for dealing with hæmorrhage have been already given. Speaking generally, tampons will suffice for venous bleeding; to be really reliable in the case of arterial it will be necessary to push the strip into the bony foramina* themselves. But the steps already fully given should amply suffice for dealing with the middle meningeal, and for avoiding the internal carotid artery. (3) Tension and bulging of the dura mater. We have seen from Dr. Ranshoff's case (p. 357), that the sitting position causes the brain to recede. This position and opening the dura if needful to evacuate the fluid must be trusted to meet the above difficulty. (4) Shock. Owing to the usual condition of the patients (p. 397) and the severity of the operation, every precaution must be taken before, during and after the operation to meet and lessen this danger. (5) Infection of the wound. During a necessarily prolonged operation this may enter by many paths. It is most likely to occur if the dura mater is opened, giving rise to escape of cerebro-spinal fluid, if this membrane and the subjacent brain are bruised by the retractor, or the use of gauze in arresting bleeding, and when the employment of tampons is extensive or prolonged. Locally, meningitis is a common form of infection; in one case a cerebral abscess proved fatal three months after the operation. Here a ligature had caused suppuration. (6) In addition to fatal hemiplegia and other evidence of damage to the brain, the use of the retractor, etc., has led to paralytic symptoms which gradually cleared up. There is reason to believe that collection of blood under the flap may also lead to hemiplegia, and require removal. (7) Ulceration of the cornea (p. 412).

I have not thought it needful to go into details with regard to sparing the motor root of the fifth by dividing the sensory one above. While theoretically desirable, this step is not a practical one. "Repeated experiment has convinced me that, in the cavum Meckelii, it is impossible to divide the sensory portion completely without sacrificing the motor root; above the cavern it is so difficult as to depend almost upon chance" (Hutchinson). Krause, after repeated attempts to preserve the motor root, has given these up. The loss of sensation causes the patients but little discomfort; they are able to take food far better than before, and the disfigurement is trifling.

* It is evident from the following words of Krause that he has known of this accident. "If the misfortune of injury to the internal carotid should occur, the first check the hæmorrhage by tightly packing the carotid canal with gauze, and the high blood pressure the tampon must be removed at least five days, and it would, therefore, be advisable to use sterilised iodoform gauze."

OPERATIONS ON THE FACIAL NERVE.

STRETCHING THE FACIAL NERVE.

OPERATIVE TREATMENT OF INTRACTABLE FACIAL PARALYSIS OF PERIPHERAL ORIGIN.

Stretching the Facial Nerve.—As will be seen from the remarks made below (p. 417), it is extremely doubtful if anything more than temporary relief, of a variable duration, can be promised by this measure.

Mr. Godlee published (*Clin. Soc. Trans.*, vol. xiv. p. 45) a case in which he stretched the facial nerve in a case of *tic spasmodique* without pain. The steps given below (p. 420) will serve for the exposure of the nerve.

The performance of this operation is easy in thin patients; in stout and muscular ones it would be more difficult. In different experiments on the dead subject the amount of tension which the nerve would bear differed very much; in some cases it resisted for an appreciable time the strongest possible pull, in others it snapped across with the greatest readiness.

The line for the nerve is exactly parallel with the upper border of the digastric, and it will be found about half-way down that part of the mastoid process which is exposed in the wound, viz., the free anterior border. The great auricular nerve will be in part divided, but as long as the operator keeps in the same plane as the digastric he can scarcely wound any vessel of importance. The deep parts of the wound are in close proximity to the internal jugular vein. The only vessels which should be met with are the posterior auricular vein superficially, and its artery more deeply, but a good deal of hæmorrhage may arise from glandular branches; and Mr. Godlee's advice to keep the wound in a good light, well opened out with retractors, and carefully sponged dry, should be remembered.

Points which deserve Attention.—(1) Finding the nerve.—To avoid needless injury and to shorten the operation, Prof. Keen* found a weak faradic current very useful. A wet sponge was held on the cheek, and a fine wire at the other end was applied to various points in the wound till the nerve was found.

(2) Mode of stretching the nerve.—Prof. Keen advises stretching from the periphery towards the centre. The amount of force to be used he estimates at four to five pounds, and this he thinks can best be achieved empirically, by attempting to lift the head (six to seven pounds), and abandoning the attempt the moment any fibres give way. In other words, the stretchings should be as severe as the integrity of the nerve will allow.†

(3) Results of the operation.—It appears that while many cases have been, temporarily, very much relieved, as a certain rule, when the nerve recovers itself, the spasms return.

Prof. Keen, in the table at the end of his paper, gives two cases in which the cure lasted much longer, if, indeed, it may not be called permanent—viz., Southam's,‡ in which there was absolute relief for five years, and one under the care of Jesus,§ in which the cure had lasted two years and eight months.

* *Annals of Surgery*, July 1886, p. 13. In the moist condition of the wound a strong current will produce muscular spasm at once, but a very weak current will only do so when the nerve is touched.

† Two cases are quoted—those of Eulenberg and Schüssler—in the first of which the nerve was "physically disorganised" by the stretching, while in the second the nerve lay in a small loop in the cavity of the wound; yet in each the paralysis gradually disappeared and the spasms partially returned.

‡ *Lancet*, August 27, 1881; *ibid.*, April 10, 1886.

§ *Wien. Med. Week.*, No. 2, 1884, and No. 27, 1887. It is an interesting fact that on paralysis followed in this case.

Prof. Keen's concluding words are as follows: "It would seem, therefore, that, whether viewed from the point of palliation or of cure, the operation is, with our present knowledge, to be looked upon favourably. Further observations may show its inutility, but when we consider the utter hopelessness of improvement, much less recovery, from any other means, relief by this operation, even if temporary, is had at a very trivial cost, and would be welcomed by any sufferer, while permanent cure is not impossible."

Mr. Godlee in a second paper,* in which he published the result of his first case—after practically remaining absent for nine months, the convulsions suddenly returned subsequently to a severe nervous shock, and gradually increased until they regained all their former intensity—sums up less favourably: "In discussing the question of recommending the operation to a patient, we must not forget that the risk, with due care, is almost *nil*; that a certain immunity from the trouble may be safely promised for a time, and that this period may be very considerably prolonged, and, while Southam's remarkable case remains completely well, there is always the hope that the relief may be permanent. Were it not for this, however, I am afraid that the general verdict would be that the time has come when this small chapter of surgical therapeutics . . . must be closed."

It is, of course, to be understood that no patient would be advised to submit to the operation without a thorough trial of other remedies, short of nerve-stretching.

And, after submitting to stretching of the nerve, patients should be most careful to avoid any exciting and predisposing causes of a return of their trouble—viz., exposure to cold chills, sudden bright lights, mental worry, and insufficient or improper food.

OPERATIVE TREATMENT OF INTRACTABLE FACIAL PARALYSIS OF PERIPHERAL ORIGIN.

Operations have lately been devised by anastomosis of the facial with the spinal accessory or hypoglossal nerve with a view of improving intractable facial paralysis originating in its course through the temporal bone, or just outside this bone, from injury.

Enough definite knowledge from a sufficient number of cases carefully watched for a sufficient period is gradually accumulating to show how far this operation, which is not an absolute *cure*, can be relied upon to afford *relief* which will outweigh the disadvantages which it entails. To consider this in a little detail, the operation can only prove a cure if the cortex can be sufficiently educated, and if the patient will persevere with this education, so as to accomplish independent movements of the face dissociated from those of the shoulder or tongue. A few cases show that this result has been completely†

* Both Mr. Godlee's second paper (*Clin. Soc. Trans.*, vol. xvi. p. 220) and Prof. Keen's (*loc. supra cit.*) contain tables, the former giving thirteen, the latter twenty-one cases. Mr. Godlee's case was unwilling to purchase relief † by submitting to permanent paralysis of the affected side of her face. ‡ the very obvious nature of the deformity.

† In several of the cases so carefully reported below evidence of partial recovery is given. Thus in the one . . . Ballance, of

accomplished. Short of this, the chief advantage is that in a certain number of cases, not in all, as the facial muscles gain some power of movement associated with those of the shoulder or tongue, they regain some tone also, and thus the flaccidity of the face disappears. But if this gain follows, it only shows itself when the muscles are at rest. In the great majority of cases the paralysed side of the face long remains motionless when the opposite one is in action, as in laughing. The only movements possible on the paralysed side, *e.g.*, after facio-accessory anastomosis, are those associated with movements of the shoulder. If the patients desire to contract the facial muscles, they must move the shoulder. This is certainly true for a period varying from three to eighteen months. As the play of the facial muscles is the index of the state of the mind, it is clear that as long as they act only in association with those of the shoulder, any movement of the muscles of the shoulder may cause an expression of the face which is not in the least in harmony with the state of the mind. This has been met with frequently. A good instance is given in one of the seven cases published in a paper by Mr. C. A. Ballance, Mr. H. A. Ballance, of Norwich, and Dr. Purves Stewart (*Brit. Med. Journ.*, May 2, 1903). The patient had been operated on nine months previously.

"The flaccidity of the face had disappeared, so that when at rest it was practically symmetrical. No voluntary movement could yet be performed without simultaneous elevation of the shoulder. Moreover, the facial movements were so easily elicited by slight shoulder movements that the patient had to carry her parasol or umbrella in the right hand instead of the left, otherwise involuntary facial movements so readily occurred that awkward misunderstandings with strangers resulted."

Another inconvenience is the atrophy of the shoulder muscles which follows, though this, as a rule, disappears if the anastomosis be performed as advised by Mr. Ballance and others.

As to the nerve to be selected, the conclusion arrived at by the writers of the above paper is that facio-hypoglossal anastomosis is preferable to facio-accessory,* for these reasons. (1) The nearness of the cortical centre of the tongue to that of the face. (2) The fact that some of the movements of the tongue are closely associated with those of the face. To these, it may be added, that during the period in which the movements of the face continue dependent upon those of the tongue, less awkwardness will result owing to the latter being hidden from view. As to the date of the operation, the writers are of opinion that when the paralysis has lasted six months, no recovery is

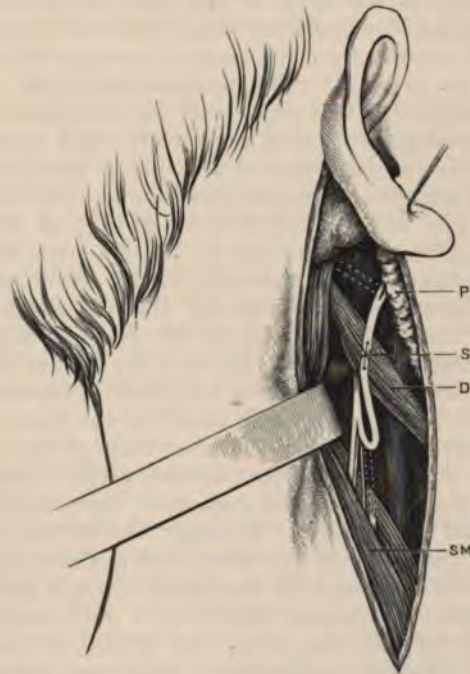
Norwich, the patient, eight months after the operation, could close the eyelids completely by a strong effort. Ten and a half months after the operation the food no longer lodged in the cheek. Dr. Kennedy (*Brit. Med. Journ.*, June 6, 1903, p. 1348) writes that his patient had "recovered the power to make independent movements of the orbicularis palpebrarum, giving a practically normal use of the eyelids, independently of any contractions of the sterno-mastoid or of the trapezius, and also that other imperfectly co-ordinated movements of other muscles of the right side of the face were recovered." "Distinctive improvement" was still going on four years after the operation. Mr. C. A. Ballance's latest results are given below (p. 420).

* In a letter (*Brit. Med. Journ.*, May 30, 1903) Mr. Ballance shows that Prof. Bernhardt, of Berlin, also prefers facio-hypoglossal anastomosis.

to be expected, and the sooner the operation is performed after this date the better. Mr. Ballance and Dr. Kennedy pointed out that the surgeon should communicate to his patient as accurate a knowledge as possible of the extent of recovery, partial or complete, which the operation offers.

In the majority of cases the operation will be performed for paralysis due to disease of the temporal bone; much more rarely after fracture of the base (case v. operated on by Mr. Ballance (*loc. supra*

FIG. 146.



P, Parotid. D, Digastric. SM, Sternomastoid. At s the branch of the spinal accessory to the trapezius, cut long, has been looped up over the digastric, and united, end to end, to the divided facial. (Faure.)

cit.)), or wounds outside the skull. Thus Mr. Ballance mentions a case of this kind in which he was unable to complete the operation as the trunk of the facial nerve had been carried away by a bullet. Harvey Cushing, who reviews the whole subject (*Annals of Surgery*, May, 1903), also reports a case of paralysis due to a revolver bullet.

After removal of the bullet Cushing waited until the wound was soundly closed, fearing that otherwise it might cause infection of the one which he proposed to make. A facio-accessory anastomosis was made by end-to-end suture over the posterior belly of the digastric. Improvement in mastication and taking food followed very early, and, six months after the operation, it is stated that "considerable improvement was appreciable."

It is pointed out that the success of the operation depends largely upon the delicacy with which the nerves are handled, upon their accurate approximation with the least possible suture-material, and that placed only in the nerve sheaths—Cushing used the most delicate strands of split silk—upon absolute hæmostasis, and upon the care with which the tissues are handled, since it is of the utmost importance that there should be a minimum of scar formation.

Operation.—(Fig. 146). The following steps will suffice for exposure of the facial, the spinal accessory, and the hypoglossal nerves.

A free incision is made along the anterior border of the sterno-mastoid, beginning at the level of the base of the mastoid process. After division of the dense fibrous tissue here the muscle is retracted, and separated if needful from the mastoid process, the anterior border of which must be exposed. The posterior auricular vessels are cut. Lying a little anterior to this point, and on a deeper level, is the base of the styloid process across which the nerve runs towards the parotid gland. The lower and back part of this gland having been freed and drawn forwards and the digastric downwards, the facial nerve will come into view, and is to be followed up as high as the stylo-mastoid foramen. The spinal accessory will be found a little below the digastric, running downwards and outwards to the sterno-mastoid. When this nerve is chosen for anastomosis, different methods have been employed. M. Faure having found the main trunk preserved the branches to the sterno-mastoid. He took the branch to the trapezius, cutting it from this muscle as long as possible, separated it from the spinal portion, so as to bring it up easily in the form of a loop, with the concavity upwards over the posterior belly of the digastric, where it was fixed by end-to-end suture to the divided facial. Later, he preferred to fix the branch to the trapezius "end-to-side to the uncut trunk of the facial" (Ballance). Kennedy divided the spinal accessory nerve, with the exception of one side of its perineurium, and sutured, end-to-side, the divided trunk of the facial into this gap.

The *after-treatment* consists mainly in a judicious stimulation by daily galvanism for months, after the wound is healed. This is continued until faradic excitability reappears, when faradism is substituted.

Mr. Ballance wrote to me, June, 1905: "I do not do now the end-to-side anastomosis" (illustrated in Fig. 12, *loc. supra cit.*). "In *facio-accessory anastomosis* I divide the accessory, except a small portion of the sheath, on one side, and then unite the cut end of the facial *end-to-end* to the upper segment of the accessory. This means temporary paralysis (two to three months) of the sterno-mastoid and trapezius. In *facio-hypoglossal anastomosis* I divide the hypoglossal at the posterior border of the hypoglossus; the proximal end is united to the facial *end-to-end*. I then divide the gustatory and unite its proximal end to the distal end of the hypoglossal so as to get return of movement in the muscles supplied by the hypoglossal."

"Case vi. had perfect dissociated movement of the face at the end of eighteen months. Case vii. is dead of malignant disease, I believe. Case viii. has now dissociated movement in speaking and laughing. I have been told of two cases of independent dissociated move-

appearing after three months in facio-hypoglossal anastomosis. This anastomosis appears the best, as the centres for movement on the cortex of the tongue and face are close together."

RESTORATION OF STENO'S DUCT.

Where, after burns, stabs, ulcerations, sloughing, operations for removal of growths, a most annoying salivary fistula persists, the patient suffering from disagreeable hot dryness of the mouth, and from constant irritation and inflammation of the soft parts from the dribbling of saliva, where previous measures—*e.g.*, collodion and heated wire, paring the edges—have failed, the surgeon may adopt one of the following measures:

(i.) This will often succeed in a recent case.

The opening into the mouth is first found, or one in its position made, by passing a fine silver probe from the fistula into the mouth.* As soon as the oral opening is found or established, the probe is passed from the mouth along the duct, beyond the fistula, up to the gland itself. The other end of the probe is then brought out of the angle of the mouth, curved, and secured by strips of gauze and collodion on the cheek, while the fistula is kept as dry as possible, and covered with collodion, in the hope that it will close,† now that the oral opening is re-established, otherwise the fistula must be closed by operation.

Mr. H. Morris (*Clin. Soc. Trans.*, vol. xiii. p. 144) has recorded a case which he successfully treated on the same lines, but with a fine catgut bougie, which is much more easily worn than a probe. He also suggests that it would be well, if, during any operation on the face for removal of a new growth, it be found necessary to divide the duct, that a bougie should be passed at once, and the patency of the duct secured.

(ii.) In cases of longer standing, where the duct is more obliterated, especially at its narrow oral end, and the restoration is not so easy, some such operation as Desault's must be performed. The following modification is that of Kaufmann. The account is given by Prof. Küttner (v. Bergmann's "System of Practical Surgery," *Amer. Trans.*, vol. i. p. 614). A fine trocar and cannula are pushed through the cheek from the fistula forwards and inwards into the mouth, following, as far as possible, the course of the duct. "A fine piece of india-rubber tubing is passed through the cannula, the latter being then withdrawn, so that one end projects into the mouth, while the other is cut off somewhat obliquely, and placed so that the saliva can flow directly into the tube. One can also simply permit the tube to project upon the cheek. The tube remains in place eight days, and is then shortened at both ends close to the level of the skin and mucous membrane. In eight or ten days more it is removed entirely. The saliva will now flow through the new canal into the mouth, and the external fistula will close by itself or after cauterisation or direct suture. Kaufmann's

* Close to the projection of the mucous membrane, which usually denotes the position of the orifice of the duct, opposite to the second upper molar tooth.

† If this fail, a plastic operation of paring the edges and uniting them with numerous fine fishing-gut and horsehair sutures will probably be required.

method is simple and rational and suited for buccal as well as masseteric fistulæ. With a buccal fistula it is simply necessary to puncture the cheek at the abnormal orifice in a straight direction, or with a slight deviation to the front; with a masseteric fistula, however, one must be careful not to push the cannula through the masseter, for a foreign body in the muscle is not borne well, since it causes severe pains and even trismus; besides, the long track will readily close again if it runs between muscle fibres. Hence in a masseteric fistula the trocar must first be pushed from the opening of the fistula subcutaneously to the anterior edge of the masseter before the oral mucous membrane is perforated." In order to thoroughly establish the patency of the new duct catgut or a very fine piece of laminaria tent (Erichsen, *Surgery*, vol. lii. p. 557) will probably be required to prevent the tendency to close.

Instances of treatment by direct suture and different plastic operations, especially indicated in masseteric fistulæ, will be found given by Prof. Küttner. If every other step fails, he advises that a partial resection of the parotid gland, with careful avoidance of the facial nerve, be performed.

When the patency of the new duct is thoroughly established, the external aperture may be closed by collodion, the cautery, or paring the edges, according to its size.

OPERATIVE TREATMENT OF LUPUS.*

We owe to German surgeons our knowledge that, from the infective power of this tubercular growth, it is impossible, when once it is established, to cure it by constitutional treatment. A further step has been the gradual replacing of local treatment by caustics or the cautery by the erosion method of Volkmann (*Germ. Clin. Lect.*, Syd. Soc. transl., p. 97). Lupus is so frequently met with in this country, the deformities which it produces are so odious, and it is so certainly arrested and cured in many cases by local treatment vigorously applied and energetically repeated, that a few practical remarks will be made on the chief methods of treatment.

Before speaking in detail of these methods it will be well to say a few words about the chief forms of lupus, and to which of these erosion or scarification is best suited.

I think that for the purpose of treatment the surgeon should keep two great types before his mind. In one of these the lupus deposit takes the shape of more or less localised nodules or nests, reddish or yellowish pink, often quasi-gelatinous, and prone to attack the cheeks near the junction of the alæ and the upper lip. In the other the lupus deposit is much more diffused, usually, too, more superficial and less inclined to form nodules or nests. This type is met with both on the cheeks and nose, but is best seen on the latter. It is, in my experience, the form much the most frequently met with in the surgical wards of a London hospital, and is the one most often

* The above account, while introduced here from the greater frequency of lupus on the face, is, of course, applicable to the disease elsewhere.

responsible for marring the above important features in young patients, usually girls. This is the lupus seborrhagicus of Prof. Volkmann,* the seborrhœa being of secondary importance, the essential point being the fine-cell lupus infiltration of the cutis, which develops most freely in the neighbourhood of the sebaceous glands, in which the cheeks and nose are so rich, and gives rise to an increased secretion on their part.

Caustics.—Mr. J. Hutchinson thus compares the three chief methods of local treatment (*Brit. Med. Journ.*, May 1, 1880): "All are very good, but I unhesitatingly prefer the last [*viz.*, *eration*]. If caustics are used, they must be used very freely. I have repeatedly seen a patch wholly cured by a single dressing with chloride of zinc or acid nitrate of mercury. As a rule, these remedies are used too timidly or without sufficient painstaking. They give more pain than the actual cautery, but their sores granulate better and heal more quickly. The actual cautery is comparatively painless, can be easily limited, and at the same time made to act deeply. It is very efficient, but its burns are somewhat slow to heal. The *eration* treatment appears to give less pain, to be very efficient, and to leave a sore which heals rapidly and soundly." From my experience, the use of caustics is open to the following great objection. If used in sufficient strength and thoroughness to eradicate the lupus, they destroy more tissue than is necessary, and leave wounds which are tedious in healing, and scars which are much more conspicuous than those of *eration*. If used diluted and with caution, they are liable to leave behind many small nodules of lupus, while, at the same time, they set up a hyperæmia which favours a more rapid spread of the disease which is left. For the above reasons I have not used them save in the form of finely-pointed sticks of silver nitrate as described below, or nitric acid, or acid nitrate of mercury on finely-pointed carriers of some hard wood.

Messrs. Watson Cheyne, C.B., and Burghard (*Manual of Surgical Treatment*, pt. v. p. 101) recommend the use of pure nitric acid after *eration* with curettes, large and small. The bleeding is first arrested by pressure, and the nitric acid is painted on with a glass brush and allowed to soak in thoroughly. The best plan for introducing the acid into the small depressions left by scraping out isolated nodules is a fine pointed glass rod. Care must be taken to cover the eyes to prevent the fumes affecting them. As a rule, the application of the caustic provokes bleeding, and this necessitates precautions designed to prevent the acid being washed by the blood over the skin and burning

* Prof. Volkmann (*loc. supra cit.*, p. 105) gives the following life-like description of this form: Irregular, reddish-looking patches met with on the cheeks and nose, often covered with "dirty-looking, thin crusts, which are distinctly fatty to the touch. They consist, in fact, of nothing further than an excessive secretion from the sebaceous glands of the skin mixed with epidermis cells. When we have succeeded, with great difficulty, in scraping off this fatty layer with the knife, the underlying skin appears red, sore, and as if studded with fine warts. But if you examine these warty points more closely with a glass, you see that it is by no means a question of papillary elevations, but of a large number of fine holes, which, being closely adjacent to each other, produce the warty appearance. These holes are the enlarged openings of the sebaceous ducts, and you can also see on peeling off single fatty crusts how a fine prolongation of the latter becomes detached from each small opening."

it. Any bleeding thus caused should be checked by pressure, and, when this is done, fresh nitric acid is applied. The cauterisation should last for about ten minutes, and then the surface may be thoroughly doused with a solution of carbonate of soda—a handful of washing soda in a pint of water is the most convenient form. This is poured over the cauterised area until all effervescence ceases, after which a piece of boracic lint dipped in the same solution is applied for a few hours, when it is replaced by boracic acid fomentations, which are renewed frequently until the surface begins to granulate. Boracic acid ointment is then employed. When a large area is thus healed, the granulations should be cleared away in about a fortnight and the raw surface skin grafted in the usual manner.

While on this subject I should like to say a few words about the use of formalin, which I have been trying lately in lupus. The chief objection is the pain which I have been able only very partially to allay with eucaine. My attention was first drawn to this method by the following:

Dr. Scatchard (*Brit. Med. Journ.*, 1901, vol. i. p. 1,078) related a case of lupus, in the ulcerated form, on the nose, of four to five years' duration, in which the use of formalin (formic aldehyde 40 per cent.) and glycerine in equal parts caused marked improvement if not a cure. Orthoform was applied about an hour before the formalin was painted on, and the treatment was almost painless. Three small patches which reappeared nine months later were dealt with in the same way, and there had been no further reappearance for four months.

This method deserves a fuller trial in cases where the light treatment is not within reach, or an anæsthetic not available or contra-indicated.

Erasion.—This is most strongly indicated in both the above forms of lupus, whether localised or diffused. Combined with scarification, it is the mode of treatment best adapted to the largest number of cases. The best instruments are sharp steel spoons, with oval ends of varying size, some quite small; the best are, in my opinion, two in which the curette and pointed scarifier are combined (Down Bros.). Several sizes of scoops, down to very small ones, are most essential. One prolific cause of the reappearance of lupus is that the large spoons usually employed miss the smaller deposits lurking in depressions in the corium. Another is that after each application of the curette this or whatever instrument is used is rarely wiped, thoroughly cleaned, and placed in some sterilising fluid; thus, of course, a risk is present of carrying infected tissues into those which are sound. This precaution is nearly always neglected. An anæsthetic having been given, the surgeon, using first one of the larger spoons, goes with deliberate thoroughness over the entire surface of the patch of lupus, using the spoon from below upwards; and if there are several patches, *e.g.*, on the face, he begins with the lowest, so that his work shall not be obscured by hæmorrhage. With the spoon all the overlying yellowish-red, greasy crusts, all the surface below these that the spoon finds to be abnormally soft, *i.e.*, something like a patch of decay in an apple or pear, are deliberately and thoroughly scraped away. The bleeding, which is usually free, is now stopped by firm pressure with iodoform or salicylic wool. The edge of the sore is then in its turn attacked in the

same way, the track of the spoon being next smoothed down by running a pair of scissors curved on the flat around the edge of the patch. The surgeon, now that the hæmorrhage is arrested, returns to the surface of the patch. Any suspicious spots are scraped again. There need be no fear of doing too much and thus causing needless scarring. The deeper layers of the corium are naturally tough and dense,* and there is no danger of their yielding to the spoon, the action of which is at once checked when the operator, by the change in the sensation of resistance, is aware that he has reached healthy tissues. The bleeding having again been thoroughly stanchcd, minute nests may often be found lying in pockets amongst the meshes of the corium. These are a potent source of reappearance of lupus, being left after all that is soft and friable has been scraped away. They are to be dug out with small spoons, or destroyed with the scarifier, finely-pointed sticks of silver nitrate, or fine cautery. While the bleeding is being finally stanchcd, the operator turns his attention to the vicinity of the lupus patch which he has attacked. The minutest points, specks, and nests are scrutinised and destroyed with a fine-pointed cautery. Where the nose or its vicinity is affected, the inner aspect of the orifices should be inspected in case the mucous membrane is invaded. Before the patient is allowed to come round from the anæsthetic, all old lupus scars are examined. Any deposits in them are attacked in the same way, or, if they are the seat of a diffuse hyperæmia and infiltration, linear scarification is thoroughly resorted to.

The best application to the surfaces left by erosion has been much disputed. For myself, knowing the inveterate tendency of the disease to reappear in minute islets overlooked (many of them) at the time of the erosion, I now always use fine-pointed sticks of nitrate of silver, or strong nitric acid on hard wooden carriers of varying sizes, to the edge and surface of each erased patch, looking out especially for any suspicious specks or nests in the exposed corium. It is a painful remedy, but this objection must give way to its efficiency. Iodoform is used by some. My chief objection to this is that I believe it, when long continued, to have a tendency to encourage flabby granulations. Lotions of hyd. perchlor. (1 in 2000) have the advantage of promoting asepsis, and of a germicide power which may be helpful here in destroying the bacillus with which we have to deal. If much pain be present, hot boracic acid fomentations should be applied. Powdered nitrate of lead is strongly recommended by Messrs. Ashby and Wright (*The Diseases of Childhood*, p. 747): "The repeated application of powdered nitrate of lead has been very useful in our hands, both for lupus and other intractable tuberculous sores; it is somewhat painful, but very effective."

To two other points in the after-treatment I desire to draw attention. One, the need of keeping the wounds clean and as aseptic as possible. It is well known how much the ravages of lupus are due not only to the lupus itself, but also to the presence of pus-cocci, this being

* As pointed out by Prof. Volkmann (*loc. supra cit.*, p. 114), in cases of lupoid ulcerations of longer standing, an almost fibroid tissue becomes exposed after the diseased parts have been scraped off, a condition which is to be re the expression of reaction in the neighbourhood.

especially the case on a part like the face exposed to the air, particularly in regions like the nose and mouth. The second point is that as the wounds granulate there is a marked tendency to scab-formation. Nothing can be more dangerous than the advice sometimes given to leave these scabs alone as the wounds will heal under them. They should be regularly removed daily, with the gentle use of finger-nail or dressing forceps, and some such application as equal parts of carbolic oil and compound tincture of benzoin applied to the surface itself of the sore that remains to heal. Any prominent granulations should be sedulously shaved down with scissors curved on the flat. When they become persistent, or the wound stationary—and this is certain—erosion, under an anæsthetic, is to be at once again resorted to. As in all tuberculous diseases which cannot be cured by one operation, the need of repetitions of this, the necessity of prolonged watching and after-attendance, must be clearly accepted by the patient or friends before treatment is commenced.

Scarification.—This is only useful in the more diffuse forms, and as an aid to erosion; it should be employed in two ways. (a) *Linear.* With a fine and very sharp scalpel the surgeon makes scores of fine delicate cuts, parallel with each other, through the diffuse lupoid deposit, crossing these again with similar delicate incisions at a right angle to the first.* Each incision should start and end in sound tissues, the knife being quickly drawn through the lupus deposit. The depth to which the blade is sunk varies with the disease. All the incisions must be made quickly and with a light hand, and care must be taken, as far as possible, not to let them run into each other. The bleeding is extremely free, but is readily arrested by carefully-maintained pressure with iodoform or salicylic wool. To save time an assistant keeps up pressure on one patch, while the surgeon attacks another.

(b) *Punctiform.* Here hundreds, maybe, of punctures are made in the diffused lupoid deposit, a delicate hand being again required, and a fine sharp scalpel-point, the pointed scarifier (p. 424), or a large needle being used. In this case, also, every pains must be taken to place the punctures equidistantly. After arresting the bleeding the surgeon looks carefully over the patch; if at any spots his incisions or punctures are crowded together, with intervening places but little touched, he again goes over the ground carefully.

If, after the completion of these operations, the tissues appear tallowy or whitish, there need be no fear of gangrene, the parts being far too well supplied with blood. The object of scarification is, of course, to obliterate the lupoid deposit by the formation of scar-tissue. It is also very useful when a scar, though not again ulcerating, remains obstinately dark bluish-red. Scarification is only to be used as subsidiary to the sharp spoon or other methods, especially when the lupus deposit is diffuse. Used by itself as a means of cure, it is tedious and brings about amelioration, not a cure.

* No scarring need be feared from either form of scarification. After three weeks have elapsed, the above incisions, however numerous, if done with proper delicacy, can only be detected by looking for them very closely. In three months it usually requires a lens to find them.

An anæsthetic should invariably be given.* Repetitions are usually required in severe cases, two or three times at intervals of three weeks or more, or whenever minute reddish specks appear and grow.

The Actual Caustery.—This method will be found occasionally useful where lupus attacks mucous surfaces—*e.g.*, the palate, cheek, &c. In such cases, the patient being placed on one side near the edge of the table, the mouth well opened in a good light, all granulating or ulcerated surfaces are first thoroughly curetted with a sharp spoon. With the blade of a Paquelin's cautery these surfaces are then repeatedly treated, and any infiltrated tissue which has not yet broken down, and thus resists the sharp spoon, thoroughly destroyed. Both the surface and edges of the lupus patches should be energetically attacked, the blade being kept at a cherry-red heat. Care must be taken not to encroach upon the orifice of Steno's duct or to approach too closely the upper aperture of the larynx. As I have already said, another and the chief use of the cautery is to destroy minute foci reappearing in scar-tissue after the use of the sharp spoon or other methods. As soon as such reddish specks appear they should be destroyed by the prickers or scarifiers mentioned above, or, failing these, by a fine-pointed electric cautery, or by the acid mercury nitrate applied with a strong, finely-pointed piece of wood.

Excision.—This is a very useful method for patches of lupus situated on the trunk or limbs. For the face, where lupus is chiefly met with, it is more rarely applicable, save in the case of small patches. It is almost impossible to make sure, unless by cutting more widely and deeply than is permissible here,† that the incisions lie in really healthy tissues. It is by no means easy to get away satisfactorily the diseased portions owing to their friability and the delicacy of the subjacent fat, and it is only by cutting very widely that it is possible to make sure that the infiltrated area, invisible to the unaided eye, is removed. Hence the frequency with which, within a year, minute reappearances are seen. It is extremely difficult to maintain strict asepsis during the healing of wounds near or on the nose and lips—very common sites of the disease; and the same fact, with the additional one that it is not always possible to obtain a level surface free from disturbance, interferes with the vitality of grafts in this region. Such wounds are

* Mr. Balmanno Squire recommends (*Brit. Med. Journ.*, May 1, 1880) freezing the skin with ether spray. This so entirely alters the feel of parts that I have not used it. Cocaine has been recommended. I strongly urge general anæsthesia in every case. Lupus, like all tubercular diseases, should be dealt with like malignant disease, no chance being thrown away. For rendering scarification expeditious and precise, Mr. Squire has devised a multiple linear scarifier. This instrument (Weiss) is most useful in port-wine stains; for lupus I prefer fine, very keen scalpels, which will suffice both for linear and punctiform scarification.

† Mr. Bidwell, in the discussion at the Medical Society on Mr. Bruce Clarke's paper (*Med. Soc. Trans.*, 1893, p. 298), "recommended that in long-standing cases the subcutaneous fat should be removed in addition to the skin, since it is found to be altered in consistence in these cases." Every surgeon who has operated much on lupus will agree with this advice, but its result on the face in producing scars, if the grafts do not live, is easily to be foreseen. Kramer (*Centr. f. Chir.*, 1892, Bd. 8) goes further than Mr. Bidwell, advising that the knife should pass one centimetre from the limits of the lupus, and deeply to or into the muscles, bone, or cartilage.

likely to be followed by tedious healing, largely by granulation, and scars, often prominent, and cheloid. Later on, when the excision wound is healed, small red spots of reappearance are very commonly met with in and around the scars. Having tried excision of lupus on the face, and having seen the results of the operation in other hands, I do not advise it here, save in one spot. This is the forehead, where the laxity of the soft parts admits of free use of the knife. If used with the freedom which is absolutely requisite it entails needless mutilation, especially on parts like the nose and cheek. It will be said that covering the fresh wound with grafts of living epidermis will prevent any contraction and deformity. Theoretically it will, but practically such a result is by no means certain on the face, especially in restless children. Finally, I am of opinion that erosion, if careful and thorough, and followed by adequate scarification, will bring about quite as good results, and with much less mutilation. The only part of the face where I use excision widely is in cases of extensive lupus of the lips. Here flaps of skin and mucous membrane may be turned up and down, and a long intervening wedge of the lupus-infiltrated tissue excised, the flaps being united by horsehair sutures. When the wound has healed it will be found that the teeth are somewhat unduly exposed, otherwise excision here gives excellent results. And where long-standing lupus of the face has extended to the gums, excision should be used freely. Teeth should be drawn beyond the limits of the disease, and the alveolar process should be removed with a chisel, as in the operation for epulis, p. 476. Owing to the freedom with which the diseased parts can be cut away here, the result is a speedy and permanent cure. The skill of the dentists of the present day will prevent any resulting disfigurement.

Those who make use of excision must cut wide of the disease, and well into the fat beneath. All hæmorrhage must be thoroughly stopped, as it is well to apply Thiersch's grafts immediately to obviate the contraction which would follow if the wound were left to granulate for a time, and also to do away with the need of a second anæsthetic. A collodion gauze dressing is more secure than bandages.

The following hints will be found useful in the treatment and after-treatment of a disease which is second to none in its frequency, its inveteracy, its power of disfigurement, and the want of credit to modern surgery which its results still too often show.

1. Unsparing thoroughness is to be employed, especially at the first time of operation; there should be no hurrying; hæmorrhage should be completely arrested, and the minute foci spoken of at p. 425, deep-lying as well as superficial, searched for in a good light and energetically destroyed.
2. An anæsthetic should be given each time.
3. The very great probability of relapses and the need of repetition of operations should be explained to the patient and friends, and their co-operation secured from the first.
4. The patients are not only to be kept under observation for a long time, but should be seen with additional frequency in the autumn, winter and spring. The points in the scars which at once call for operative steps are the appearance of reddish specks or nodules, one or more scars remaining obstinately dark bluish-red or purple, and the persistent appearance

of scales or scabs. 5. As in all tuberculous affections, while local treatment is of the chief importance, the general health must be looked to and every possible step taken to improve it, more especially by nutritious food and the best bracing air obtainable. Such common diseases which lower the vitality, *e.g.*, bronchitis and influenza, must be carefully avoided. In brief, routine after-treatment should be as carefully carried out as the minutiae of the technique at the time of the operation.

Light* Treatment in Lupus.—So much has been written of late years on this subject that my readers will have no difficulty in forming an opinion from the numerous papers. For myself, I have arrived at the following conclusions. The *advantages* of the method. The scars are less disfiguring and more pliable than after the usual operative steps. There is no risk from an anæsthetic. The claim that the method is always painless must be accepted with reservation. It is usually so in experienced hands. For the other side of the shield I refer my readers to a paragraph, "The Light Treatment of Lupus from a Patient's Point of View" (*Brit. Med. Journ.*, vol. i., 1902, p. 162). Patients having no fear of an anæsthetic or operation will come earlier for treatment. They are better able to continue their work. Where the disease reappears† patients are more likely to submit to treatment many times.

Of the *disadvantages* we, naturally, hear much less. Even at the present day it is not always possible for patients far away in the country to get to one of these centres where the light treatment, with its very expensive plant, and especially skilled staff, is available. When they are able to do so, the long time required—upwards of a year being needful in an extensive case—the expense of time and money, are not to be forgotten. And with lupus, as with all tuberculous cases treated slowly, there must always be the risk of the disease spreading at one spot while it is being dealt with at another. Of the frequency of dermatitis and the interruptions in the treatment which this complication may bring about, of the risks to the operator himself, I say nothing. For the latter, every one who is beginning to work at the light treatment should refer to a candid and honourable paper by Dr. J. Hall Edwards, "On Chronic X-Ray Dermatitis" (*Brit. Med. Journ.*, 1904, vol. ii. p. 993).

The light treatment is best suited to cases of course in which the patch is limited; and there is every reason to hope that if general practitioners are more emphatic in impressing upon their patients that lupus is the same as "consumption," only limited to the skin, and that it will ultimately destroy one or more features as it destroys the lungs, patients, where the light treatment is available, will resort to it at once. The light treatment will thus have full justice done to it, and

* I have said nothing about the different merits of X-rays, Finsen light, radium and high frequency methods. These are matters for experts only. Numerous and very diverse opinions will be found in the medical journals of the last few years. An impartial one, and based on much experience, is that of Dr. Sequeira (*Brit. Med. Journ.*, vol. i., 1904, p. 982).

† In speaking of tuberculous or malignant disease the term recurrence should be dropped. Re-appearance would be a better and more honest word to employ, as it is due to the disease having been incompletely removed on the first occasion.

its power to cure, a matter to which I shall return shortly, will then be established, while those chronic cases of extensive disfigurement—the so-called “social lepers,” will become very few. That they will disappear altogether, as has been claimed by enthusiasts, those who know most of human nature will scarcely be sanguine enough to believe. Where the disease takes the form of spot-like nodules, the treatment is much more prolonged, and the same may be said of cases attended with much scarring from previous operations. This injustice to the light treatment is a point of which surgeons should take note. Such scars result from imperfect, incomplete operations. The patients should have the advantages and disadvantages of the light method put clearly before them, and the fact that here the operations require no special skill like many in surgery, but that perseverance and patience, the absolutely needful combination of which is so rarely present. If general anæsthesia, and this is rarely prolonged—is not available, and if it is clear that the above combination cannot be relied upon, the case should at once be handed over to the light method. Lupus of mucous membranes* is another instance in which from their inaccessibility and the rate at which the disease spreads in cavities always moist and warm and of low bactericidal power, the light treatment has been less successful. In such cases, in those slight recurrences after careful thorough operating, and in very extensive cases occasionally met with in other parts besides the face, operative and the light treatment should be combined. Probably, as the wisest and the trustiest of the workers at the light method realise what it can and what it cannot do, we shall see more of combined work between them and surgeons. In justice to the light treatment I will allude to one more form of lupus, which should be placed at once in their hands. It is that which is *non exedens*, slowly infiltrating as it spreads without breaking down until the features become hide-bound in an expressionless mask. Dr. Lancashire, of Manchester, mentions such a case in an instructive paper (*Brit. Med. Journ.*, 1902, vol. i. p. 1330). Of the advantages of the light treatment, and the vast *improvement* which it brings about not only in the disease but also in co-existent scars there is no doubt whatever. We begin, I think, to be in a position to form a reliable judgment as to *how far the method can claim to be really curative*. I say “begin” advisedly. In the first place the advocates of the light treatment are largely to blame themselves for any scepticism in this matter, from the

* The conjunctiva, especially about the inner canthus, is a region sometimes affected and requiring special skill in the necessary technique. A thoughtful, well-reasoned paper by S. Stephenson on a case of tuberculosis of the conjunctiva cured by the X-rays, without any visible cicatrix, will be found in the *Brit. Med. Journ.*, 1903, vol. i. p. 1313. It is noteworthy with regard to the frequency with which lupus of the mucous membranes, especially the mouth, fauces and nose, occurs that Dr. Macintyre, of Glasgow (*ibidem*, 1904, vol. i. p. 937), states that at Finsen's Light Institute it had been found that out of a thousand cases of lupus treated there during the past six years three-fourths were suffering from lupus of the mucous membranes. It is further noteworthy that for these cases the galvano-cautery is found to be the chief resource. Lupus of one mucous membrane should always be treated by excision, viz., lupus of the alveolar process. The surgeon here has a free hand, and should remove the diseased structures widely by the method given for epulis (p. 476). Extirpation can thus be secured. The skill of our dentists will prevent any deformity later.

way in which the cases are reported. In many the final account runs on these lines:—Condition “extremely satisfactory, only a tiny spot remains which a few more applications will cure.” “The patient is still under treatment for a small crack in the nose.” And even when it is claimed that the patient is cured, or it is stated that there has been no reappearance, while full details as to the duration of the lupus, full notes of the previous operations which have failed, are given, very rarely indeed is the time specified that has elapsed since the treatment was stopped. And when this interval of cure is distinctly given it is not stated whether the patient is still under observation. Brilliant as was the discovery and brilliantly successful as has been its application to lupus, it is not going to upset the pathology of tuberculosis, or to do away with the need of remembering the wise and weighty words of Verneuil, familiar to all thoughtful men with any knowledge of the past, that operations on the tuberculous abound in “half successes,” incomplete results and unfinished cures.”

The following are some of the few cases in which the time is stated definitely in which the patient is claimed to have been cured. Dr. Gamlen, of West Hartlepool, amongst his cases published in 1903 (*Brit. Med. Journ.*, vol. i. p. 1311) gives that of a girl, æt. 18, in which two operations had been performed for a limited patch of lupus on the right cheek. He excised this and grafted the wound. Ten months later the lupus reappeared, and was made additionally unsightly by the large scar. The patient was cured by X-ray treatment, and there had been no recurrence for over a year. The following closes the report: “There is no scar to be seen, and the portion formerly affected can hardly be distinguished from the surrounding skin, with the exception of slight blanching and pigmentation.” In 1902 it was stated (*Brit. Med. Journ.*, 1902, vol. i. p. 44) that of 450 of Prof. Finsen’s cases 130 were known to have remained free from recurrence for intervals varying from one to five years after the treatment was discontinued. Dr. G. H. Sequeira, whose papers are always impartial and instructive, gives (*Brit. Med. Journ.*, 1904, vol. ii. p. 983) the statistics of the Light Department of the London Hospital, which was opened in May, 1900. Two hundred and sixteen are claimed to be cured.

Completed Cases.

Patients known to be well to date:—

Discharged in 1900 and 1901	.	.	.	49
„ „ 1902	.	.	.	60
„ „ 1903	.	.	.	69
„ „ 1904 (half-year)	.	.	.	38
				216

Such statistics, without detail, carry but little weight to my mind. What we require from trustworthy observers such as Dr. Sequeira are detailed reports of some of those cases in which three years had passed, with *photographs of the cases taken after this interval*, and a careful account of the state of the scar then and its adjacent area. Reports from patients are not sufficient. But whether we obtain such reliable evidence or no, perhaps through the aid of a committee of one of our Medical

Societies, it is clear that we shall soon be in a position to test for ourselves the claims which have been put forward for the results of the light method. If they are based upon fact, those connected with hospitals should see from time to time patients who have tested the above method applying for relief for tuberculous mischief elsewhere, or for other diseases, or accidents.

OPERATIVE TREATMENT OF RODENT ULCER.

Owing to the frequency of this disease on the face, the following remarks are inserted here.

The treatment of Rodent Ulcer, beginning as this disease does in a very small way and with very slow progress on the face, when the patient is at once aware of it, ought to be entirely preventive. If only every small flat-topped wart as soon as it begins to increase in size, to itch, &c., and if every scaly patch which tends to become sore and form a scab led the patient at once to seek advice, excision and suture in the one case and one efficient application of acid mercury nitrate in the other would amply suffice. And where the disease has been allowed to progress further and attain to the size of a sixpence or a shilling, cure would be rapid and complete if only surgeons would cut both sufficiently deeply and widely instead of using curettes, &c., and skin graft later on, if needful. Even in the smallest cases a general anæsthetic should be given before the growth is excised. In the close cellular tissue of the face eucaine does not suffice. Save in the very bravest patients, movements will occur leading to hurry on the surgeon's part, and an incomplete operation.

The following remarks refer to advanced cases only which are still occasionally met with. The light treatment in Rodent Ulcer is referred to later (p. 435).

Some points of Practical Importance.

i. *Propriety of Operation.*—In this form of malignant disease, owing to its extremely slow progress, its very long connection with some well-known flat-topped wart, patients sometimes keep on deferring the operation till their age and the extent of the ulcer cause some difficulty in urging or advising an operation.

The following may help in forming a decision: (1) The extent, depth, and site of the ulcer. A case of moderate severity—say of the size of half-a-crown—may nearly always be submitted to operation. But the difficulty of deciding will be much greater in cases which involve extensively the nose, orbit, and eye, perhaps, especially if the bones on the delicate inner wall are much involved; in the rarer cases in which orbit, nose, and mouth are thrown into one hideous chasm,* and those cases, also rare, in which the ulceration extends very widely, though superficially, involving forehead, temple, and parotid region.† (2) In all

* As in Figs. 2 to 6 at the end of Mr. Moore's work, *Rodent Ulcer*.

† Mr. Moore (*loc. supra cit.*, Fig. 9) shows one of these superficial but vast rodent ulcers, and his cases vi. and vii. prove the exceeding difficulty, if not impossibility, of completely curing them, even in hands as experienced as his. He thought (p. 58) that the firmness of the skull presented a mechanical obstacle to the complete healing of these

cases of severity the following should be carefully considered—viz., the real age* of the patient (*i.e.*, the age not reckoned by years alone); his habits; how long he will probably live if no operation be performed; whether the disfigurement seriously interferes with the following of an active life; whether there have been any brain symptoms referable to the growth; the condition of the viscera; any liability to erysipelas. Finally, each case being considered by itself, certain conditions will justify operation in otherwise doubtful cases, as when a rodent ulcer, having destroyed the sight of one eye, is creeping across the nose and threatening the opposite one.

ii. **The Operation itself.**—In these days of aseptic surgery, the combined operation by knife and caustics, or cautery, will be preferred to one by caustics alone, on account of its greater precision, the more rapid and more painless healing, the absence of foetid sloughs, and the diminished liability to erysipelas, &c. The following hints may be found useful in an extensive operation:

(1) To diminish such risks as erysipelas in these patients the parts should be carefully cleansed and kept as aseptic as possible.

(2) Steps of the operation itself and the application of caustics.—The surgeon first makes a groove-like incision† around the whole, or, in a very extensive case, around part of the growth, and well wide of it, and arrests the bleeding by ligature, by leaving on Spencer Wells's forceps, or by sponge-pressure. The next step—that of removing the affected soft parts—is often difficult, owing to their proneness to break away, and thus giving no firm hold to forceps; a sharp spoon is only permissible at first; scraping alone is not to be trusted to. Having scraped away the growth down to tissues apparently healthy, *i.e.*, where no specks of yellow-grey granulation-like material can be seen, the surgeon scrutinises these most carefully, going over them several times with a small sharp chisel or gouge with careful thoroughness. Where the bones themselves appear eaten into, scraping will not be sufficient, and it will be wiser to go over the worm-eaten surface with a fine gouge

large sores. Mr. Moore was writing, of course, before the days of skin grafting. Mr. Hutchinson (*Clin. Surg.*, vol. ii. pl. 65) points out that this extensive form may be very superficial for a long time, may even cicatrise with tolerable soundness, but that, sooner or later, a stage of deep growth and rapid progress is almost certain.

* The late Sir James Paget's words on the risks of operation in old people (*Clin. Lectures*, p. 6) may be quoted here: "They that are fat and bloated, pale, with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not indeed good subjects for operations, yet they are scarcely bad. The old people that are thin and dry and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble and soft-skinned, with little pulses, bad appetites and weak digestive power, so that they cannot, in an emergency, be well nourished." Sir James goes on to speak of their inability to bear loss of blood, the lazy healing of large wounds, the liability of their stomachs to refuse food, their prolonged convalescence, their getting "all but well," and the need of meeting these special dangers with special cares.

† A pair of sharp, blunt-pointed scissors may be found useful when the lids have to be cut through.

or chisel.* In one region especially these must be used with the utmost caution—*i.e.*, where the paper-like bones on the inner wall of the orbit are involved; in this place, if the surgeon is not satisfied with the limited use of the gouge or chisel—which is alone permissible here—he must be content with finally applying Paquelin's thermo-cautery or formalin, unless removal of the eye, at the same time, has allowed of the use of zinc chloride paste. In other places this very valuable caustic may be employed fearlessly, as long as precautions be taken to use it in a concentrated form and to apply it in a thick state and as little of it as possible, so that the discharges from the wound shall not allow it to liquefy and run either towards the eye or nose or throat. Formalin (p. 436) is safer, and, perhaps, as efficient. It certainly deserves a trial here.

(3) Question of removing the eye in cases where the conjunctiva is involved.—As a rule, consent should be obtained for this step if needful. Cases clearly requiring it will be those where (*a*) the eye is already useless, or so distinctly deteriorated that it cannot improve; (*β*) where the lids have shrunk off away from it, and left it irritable and painful from exposure; (*γ*) where the disease cannot otherwise be removed or caustics efficiently made use of.

As a rule, if the conjunctiva is much involved, the necessary removal of this will cause sloughing of the eyeball. Occasionally, this only threatens, and then passes away.

iii. **The After-treatment.**—(1) The chief object here is to keep the wound scrupulously aseptic. I prefer, for this, gently packing the wound with iodoform gauze, and over this a boracic acid fomentation changed at frequent intervals. Morphia will be required for the first day or two if zinc chloride or formalin have been used, and the bowels should be kept regularly open. If zinc chloride paste has been used, attention must be paid, as already advised, that it does not melt and run into parts like the eye, nose, or mouth, and for this same purpose the position of the patient's head must be looked to. The gauze on which it is applied should be removed at an interval of a few hours, according to the depth which the original disease has reached. (2) If it has been found needful to attack vigorously the bones of the skull, or even to apply some of the caustic to diseased dura mater, and if during the first ten days of the disease fits make their appearance, it does not necessarily follow that cerebral inflammation is setting in. According to Mr. Moore the fits may be slight and the unconsciousness of brief duration, or the fits even severe and attended with coma, but, as a rule, they are recovered from. (3) Secondary hæmorrhage. This is rare after the use of zinc chloride or formalin, which form deep, tenacious, black sloughs, and also seem to me to prevent the risk of pyæmia. But if the cautery only has been used, the amount of fœtor is much greater; and in parts so vascular, secondary hæmorrhage may easily occur if the wound is foul. (4) Reappearance. The patient must always be most carefully watched, and, in the case of extensive and deep disease, any suspicious granulations, or, at a later date, induration of

* Mr. Moore (*loc. supra cit.*, p. 51) speaks decisively on this point: "The bone itself must be taken away to a depth exceeding that which has yielded to the disease. Recurrence is otherwise inevitable."

the scar that appear, must be attacked at once. (5) After a severe operation a plastic operation—*e.g.*, the bringing down of a flap from the forehead, where the skin is thus movable—should be performed; and, this failing, much may be done by a well-made celluloid or other artificial mask.*

Light Treatment in Rodent Ulcer.—The following remarks apply only to typical cases of rodent ulcer. In epithelioma, unless inoperable, the delay of the light treatment is impermissible. Owing to the lesser frequency of rodent ulcer compared with lupus, and the smaller amount of work done, it is more difficult to draw reliable conclusions. Much of what I have said at p. 429 about the light treatment for lupus applies here also. As is natural, the most suitable cases are found to be the superficial ulcers, even when these are of considerable extent. Where there is much deposit about the edge and base the outlook is less favourable, and the time required will certainly be much longer. Probably here a combination of methods will ultimately be found best, the surgeon removing the margin and base as thoroughly as he can, and the completion of the case being carried out by the light method. Unless surgery precede the light treatment in such cases there is a risk that, after prolonged sittings, the disease, though improved, will still remain unhealed. Mr. M. Sheild points out, as an instance where a combination of methods is especially indicated, those cases of rodent ulcer where the facial nerve or Steno's duct are involved, or likely to be implicated in an operation (*Clin. Journ.*, Dec. 14, 1904). Where the periosteum and the bone are involved, too much must not be expected from the light treatment alone. It should always be tried in those difficult cases which attack the inner angle of the eyelids and this neighbourhood. But where its success is doubtful, the trial should not be too long continued, owing to the thinness of the bones here. Cases which are certainly unsuitable are those in which the growth is rapid or those of doubtful nature on the borderland or past it, between rodent ulcer and epithelioma.† It appears to me very doubtful whether they should be employed in those cases still met with occasionally at the present day where the disease has excavated its way into the mouth and nose. In such cases the course always now becomes more rapid. Extirpation on the widest possible lines, as given above at p. 433, by knife, gouge, and chisel (never the curette alone), aided by the use of formalin (p. 436), seems to me still indicated here. The resulting deformity will be terrible, but it can be largely met by a plastic operation, or if the patient prefer it, by an artificial nose and part of the upper lip, which the dentists of the present day can model so skilfully. The surgeon must be prepared for the deformity being laid to his door—an accusation which those who work at the light treatment are too fond of making.‡ For such deformities the patient must often take a

* As shown in Figs. 6 and 7 in Mr. Moore's book, *loc. supra cit.* A good example is figured in Dr. Sequeira's paper, *loc. infra cit.*

† Mr. F. T. Paul (*Brit. Med. Journ.*, vol. i, 1901, p. 321) expresses his opinion that there are certainly two forms of carcinoma of the skin-appendages in only one of which is the course of the disease

of chronic

† A

also figures an excellent instance not with.

and rodent ulcer by

large share of the responsibility, having frequently put off the necessary operation for months, or even years.

With regard to *the curative power of the light method* in rodent ulcer it is more difficult to speak than it was in the case of lupus (p. 430). And again this is largely due to the indefiniteness with which many of the reports have closed. The following, if verified after a few more years, are very encouraging: Dr. Sequeira (*loc. infra cit.*, p. 1309), writes, "Some of my earliest cases are quite free, and one extensive ulcer of thirteen years' duration, and which healed with three months' treatment by the X-rays, has remained free from recurrence for two years and eight months. I have many cases free from recurrence for a year. But in nearly half of all the cases there have been slight recurrences, small nodules appearing at the margins; these are probably due to the escape of small outlying parts from the action of the rays. In some recurrences have been seen more than once. As a rule, however, these recurrences are easily dealt with by a fresh application of the treatment."

Dr. Kassabian (*New York Med. Journ.*, Dec. 12, 1903), has treated 16 cases of rodent ulcer with the Röntgen rays, without a recurrence. In eight or nine of these four years have elapsed.

Perthes (*Centr. f. Chir.*, 1904, B. 27, S. 12) has succeeded in healing completely 12 out of 13 cases. In one, an extensive and deep case, occurring in the temporal region, healing was not complete at the end of a year. In three renewed treatment was required a few months after the apparent cure, on account of the reappearance of the disease. Ten months appear to be the limit of time which had elapsed since the cases were believed to have been cured. Three remained healed at this date.

If, as I have suggested, it will be well to continue the light treatment as a matter of routine in cases of lupus for some time after they appear to be cured, it is obvious that this course will be indicated in rodent ulcer with the above-given liability to reappearance.

As cases will still arise occasionally in which the light treatment is not available, I shall refer here to one more method—the use of *formalin*, and its employment in rodent ulcer, whether by the general practitioner (and he sees these cases first when they are most amenable to treatment)—when the disease presents itself as an obstinate scaly patch, or a small ulcer, or later in more advanced cases when the knife

the light method will be familiar with instances of the truth of the above statement. Dr. Sequeira, whose papers are always instructive and usually impartial, published two cases of rodent ulcer successfully treated by the X-rays (*Brit. Med. Journ.*, 1903, vol. i. p. 1307). His closing paragraph is as follows:—"The comparison of these two cases is very instructive. Both started at the right ala nasi, and both had lasted nearly twenty years before coming under the X-ray treatment. In one frequent operations had been performed; with the result that hideous deformity had been produced. In the other no operation had been performed, and the result is excellent." It is only right to point out that no information is given as to how long the disease had originally lasted before several operations were done in New Zealand, where it was diagnosed as lupus, and, therefore, it is only charitable to assume that it was a difficult case. Further, in the case which recovered without deformity the disease was limited to the face; in the other it had invaded the upper jaw and palate. The increased rate of progress both of lupus and rodent ulcer on mucous membranes, which are always moist, warm and of low bactericidal power is well known.

has done all that is possible, and lastly, in cases of inoperable malignant disease of the face, especially sarcoma. Anyone who is acquainted with the use of formalin in such cases will be struck by its aseptic, non-toxic and desiccant power. At p. 451 I have related a case in which it proved of extreme value in a case of sarcoma of the orbit reappearing after removal of the eyeball. Mr. McFeely, of Dublin, has shown what formalin will effect in advanced cases of rodent ulcer, even those which have crept into the vicinity of the eye (*Brit. Med. Journ.*, Nov. 8, 1903). In two of the cases, both of them severe ones, a cure was attained, in one aided by the previous use of the knife. The photographs of these cases show the excellence of the result. The objections to formalin are the pain, and sometimes the tediousness with which the dry, tenacious, odourless sloughs are cast off, as in the case related at p. 451. These objections must not be allowed to weigh against the prospect of cure when the drug is efficiently used, or, where cure is out of the question, of prolonging life in active employment, a shade of some kind being worn over the ulcer. I strongly advise that at first the strongest formalin should be used, and an anæsthetic given whether the knife is used or no, and prolonged as far as is consistent with safety. I have never been able to mitigate the pain much by the previous use of eucaïne. Where permissible, morphia avails to lessen but not to abolish the pain. Orthoform might be useful. The drug is applied thoroughly with a glass rod or a carrier of some hard wood, and then applied for a few hours on sterile gauze wrung out of the same solution, and limited to the affected surface. This is secured in place with a bandage, jaconet and cotton-wool. After a few hours this is removed and a boracic acid fomentation applied. After a couple of days the characteristic slough must be snipped away and a diluted solution of formalin applied. Mr. McFeely advises formalin glycerine 30 to 50 per cent. The snipping away of the sloughs and the re-application must be repeated every few days as is required.

What the use of formalin can effect in some cases of sarcoma is not only shown by my case at p. 451, but still better by one related by Dr. Mitchell, of Bradford (*Brit. Med. Journ.*, Feb. 11, 1899).

The case was one of fungating and bleeding sarcoma of the cheek, which had been operated on twice. A solution of caoutchouc having been applied to the skin, a pad of cotton-wool wrung out of a 20 per cent. solution of formic aldehyde was secured in place. The necrotic tissue which formed was daily curetted away and the same solution re-applied. In a short time the growth was completely removed. The pain was held in check with morphia. The œdema which occurred in the eyelids and lips, and which has also been noticed by Mr. McFeely and myself, was annoying, and, as pointed out by Dr. Mitchell, might prove dangerous in the neck, from the risk of œdema glottidis.

Another case in which a malignant growth of the face was removed by formalin (a 2 per cent. solution was used here) in about three weeks, and the surface healed by grafting, is recorded by Dr. Powell (*ibidem*, May 30, 1903).

Such cases are most instructive.

REMOVAL OF PAROTID GROWTHS.

The question of operation arises here under three somewhat different conditions, viz.:

- (i.) In the case of the ordinary parotid growth.

(ii.) In that of a sarcoma of the parotid, which has often started in the growth just mentioned.

(iii.) In carcinoma of the parotid.

(i.) **Removal of an Ordinary Parotid Growth.**—These well-known growths, containing a mixture usually of fibro-cartilaginous, myxomatous, and imperfect glandular tissue, require no special allusion here, beyond the need of—(1) Exposing them sufficiently, (2) Paying strict attention to the facial nerve, and (3) Removing the capsule itself, after the growth has been shelled out, in any cases of doubt—viz., soft consistency, or rapid growth.* (4) Watching the after-result. This must be insisted upon, owing to the view recently held that these growths often originate in endothelial, not connective, tissue elements: in other words, that they are endotheliomata. If so, recurrence is always possible.

(ii.) **Operation in Sarcoma of the Parotid.**—This disease usually begins in one of the growths just mentioned; and here the malignant change is often sudden and rapid, after a long benign period. This and the next group may, as far as operation is concerned, be considered together.

(iii.) **Operation in Carcinoma of the Parotid.**—The question of the advisability of interfering at all with really malignant growths of the parotid, especially carcinomata, has been much disputed, but as each case must be decided by itself, and as no hard-and-fast line can be laid down here, some useful practical points may be mentioned. On the one hand, attention must be strongly drawn to the fact that reports of operations are often brief, and that too often they are published as soon as the patient leaves his surgeon, and thus two-thirds of their value are lost; on the other hand, I may perhaps remind my younger readers that a malignant tumour in this region is one in which, above most others, he must not allow a wish to relieve a patient to overcome a decision arrived at after careful examination, for there is scarcely any part of the body in which a malignant growth so quickly obtains a firm hold on the surrounding structures—a fact which has even a graver bearing on the operation than the importance of these structures themselves.

A case of carcinoma of the parotid successfully removed, in a woman of 72, is recorded (*Amer. Jour. Med. Sci.*, 1893, vol. cv. p. 144).

At one spot the skin was adherent and ulcerated. The entire gland was extirpated, together with the affected skin, extending up as far as the temporal region. It was found needful to tie the external carotid, and the facial nerve was also necessarily sacrificed. The upper part of the sterno-mastoid, being infiltrated, was removed. The patient was well eight months later.

* In an article (*Guy's Hosp. Reports*, vol. xxvi.) "On the Enchondromata of the Salivary Glands," I wrote, with regard to the removal of these growths: "If the wound be made too small in the first case for fear of a scar, the edges will only be bruised, and primary union prevented. It is not uncommon for branches of the facial nerve to be in relation with the capsule of the growth, and if this has been much handled, or treated by counterirritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself."

Practical Points in the Removal of Parotid Growths.

Characters of the Growth.—Amongst the most notable of these are—(1) Mobility—viz., how far it can or cannot be lifted up by the fingers from the subjacent parts. (2) Rapidity of growth. (3) Density—thus a great hardness or evident softness will be alike unfavourable, the latter from the fact that such soft growths will break down during attempts at removal, and leave part behind. (4) Symptoms of pressure, especially of deep pressure upon the pharynx. Of these, dyspnœa, dysphagia, presence of outlying masses in the fauces, alterations in speech and in hearing, and to a somewhat less degree facial paralysis* are of evil omen. (5) Condition of the overlying skin.† (6) Involvement of the upper part of the sterno-mastoid, sometimes giving the appearance of torticollis. (7) The presence of infiltrated glands, especially if these involve the large vessels and nerves of the neck.

Points in the Operation itself.—To begin with, the growth must be sufficiently exposed by adequate incisions. Probably none will be more generally suitable than a T-shaped incision, the vertical portion lying over the large vessels, and the transverse one lying parallel with the zygoma and exposing the facial part of the growth and its accessory portion.

If the skin is adherent at any spot this should be included. The flaps are freely dissected back, covered with sterile gauze, and the hæmorrhage, which is often free, even at this early stage, entirely arrested. The surface of the growth, in its capsule, if one be present, having been completely exposed, extirpation is begun below and behind, not from above downwards. This course allows of securing the external carotid or of putting a temporary ligature on the common carotid (*vide infra*), and further, as pointed out by M. Bérard (*Maladies de la Glande Parotide*, p. 240): (1) The blood flows away from the wound, and not over the instruments of the surgeon; (2) The same vessels do not need to be tied more than once. Next, the growth is freed at the sides and above. This step is comparatively easy over the parotid, but adhesions to or infiltration of the sterno-mastoid will be difficult to deal with. There should be no hesitation in removing the upper part of the muscle. Every vessel is carefully secured, and oozing is checked by firm pressure (sterilised adrenalin solution, 1-1,000, may be useful) while the surgeon is engaged with some other part of the growth. Gradually as the growth is pulled in different directions and freed by blunt dissection—a strong pair of blunt-pointed curved scissors, used both closed and open, will be found very useful—the growth comes forward more and more, and is finally only attached about the styloid process and pharynx. Here any bands of fascia or what looks like fascia must be carefully examined and ligatured if needful; the upper part of the external carotid or its terminal branches must be found and ligatured if possible before they are divided. There

* Prof. Billroth, quoted by Mr. Butlin (*loc. infra cit.*, p. 118), considers that facial paralysis from the pressure of a parotid growth is a sign that this is probably a carcinoma, for the sarcomata and other tumours rarely produce paralysis by pressure, although paralysis frequently follows the operation for their removal.

† The more adherent, discoloured—viz., reddish-purple—are the integuments, the more unfavourable is the prognosis.

must be no hurrying at this stage, and the wound must be bloodless while any deep dissection is going on.

In addition to the free oozing, and the presence of important vessels, other difficulties which may present themselves are the breaking down of a soft growth, thus baffling attempts at complete extirpation, and the strong processes of fibrous tissue which, passing normally from the parotid to some important adjacent structures—viz., the digastric, the internal pterygoid, and the carotid sheath—are now liable to be either increased in density, or softened by extension of the growth. Where the surgeon is uncertain as to complete extirpation, formalin or zinc chloride (p. 434) should be applied, and an injection of morphia given afterwards, unless contra-indicated. If any bleeding persist low down, Spencer Wells's forceps should be left on for 36 hours. Drainage from the deepest part of the wound is always to be employed.

Two points require especial attention here—viz., the amount of facial paralysis which may be expected,* and the hæmorrhage.

Facial Paralysis.—While in the case of a smaller growth, if the nerve has only been bruised, or, when divided, if the ends have been placed in contiguity, union may take place, and the paralysis gradually disappear,† in the case of really malignant growths the question of future deformity must be set aside, and the nerve divided as soon as seen.

Best Modes of meeting Hæmorrhage.—The chief vessels which will be met with are the superficial temporal, transverse facial, occipital, posterior auricular, internal maxillary, and external carotid. The external jugular vein and the large communicating branches between it and the internal jugular are sure to be cut, while the internal jugular vein is almost certain to be seen in the bottom of the wound.

It must be remembered that not only will all the above vessels be liable to be much enlarged, but numerous other unnamed anastomoses will be present.

The common carotid has several times been tied prior to this operation. In my opinion, ligature of the external carotid with all the accessible branches is greatly to be preferred (*q.v.*).

If ligature of the common carotid is to be made use of here, I hold that it should be reserved for those cases in which the surgeon decides to attack a very soft and vascular growth, as here the vessels may be very numerous and difficult to isolate, and ligatures may not hold. In such a case, instead of tying the common carotid and thus exposing the patient to the risks of brain mischief, it would be better to pass a loop of chromic catgut ligature around the vessel, loosely tied, and to ask an assistant to keep up tension on this whenever bleeding takes place. This method seems to have been first used by M. Roux, and later by Mr. Rivington (*Med.-Chir. Trans.*, vol. lxix. p. 72) and Sir F. Treves

* If the surgeon, especially in less serious cases, when making any deep incision that is needful, can manage not to go above the level of a line drawn horizontally three-quarters of an inch below the lobule of the ear, he will avoid any serious interference with the trunk of the facial nerve, and thus escape the risk of permanent paralysis.

† This gradual improvement is alluded to, with a case in point, in my article, *loc. supra cit.* Mr. Butlin ("Operative Treatment of Malignant Disease," p. 120) suggests nerve suture.

(*Lancet*, January 21, 1888). See Section on "Ligature of the Common Carotid."

In dealing with any large veins the risk of the entrance of air should be prevented by making finger-pressure on the cardiac side, or by securing them with double ligatures before they are cut.

If the wound has become infected—and sometimes in these operations near the mouth and nose it is impossible to keep the bandages from shifting—the surgeon must always be prepared for the accident of secondary hæmorrhage. And on account of the same risk the actual cautery should never be used at the bottom of a very deep wound near to any suspicious tissues, if it can possibly be avoided. If some kind of caustic be required, zinc chloride paste, used with the precautions given at p. 434, would be preferable from the absence of fœtor with which it works; and formalin better still.

OPERATIVE TREATMENT OF NÆVI.*

The first question which usually arises is whether these growths should be operated on at all, or whether they may be safely left to themselves. While there is a distinct tendency for nævi, after a term of life, to undergo fibro-cystic change, I doubt if this tendency to spontaneous disappearance is as high as Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 702) put it—viz., that "certainly more than half are thus naturally cured." In private practice, where a nævus is not extending,† where it is in neither a dangerous nor a conspicuous place, it is justifiable to watch the nævus, remembering that the times of teething and of puberty may bring about atrophy or increase, and that the former, while often spontaneous, is most likely to follow one of the exanthemata. But where a nævus has any of the cavernous element about it, when it occupies a dangerous site, one where irritation of any kind is likely to bring about hæmorrhage—*e.g.*, scalp, lips, tongue, palate, genitals, rectum, fingers, or toes—or where the site is a conspicuous one, no time should be lost in effecting a cure.

While admitting that, after a year, there is a distinct tendency for a nævus to become stationary, and often to degenerate ultimately, I should advise operative treatment in nearly all cases, for the following reasons:—(1) During its growing and stationary stage the nævus is always a source of anxiety and often of disfigurement. (2) This growing stage commonly lasts for the first year. When a nævus appears to be stationary, or even cicatrising at its centre, it may be spreading at its periphery. (3) In hospital practice there is the greatest difficulty in persuading the mother to put up with any

* I have spoken of their treatment now for convenience sake, and because of their great importance on the face.

† On this point Mr. Waterhouse (*Clin. Journ.*, Aug. 25, 1897) gives the following hints:—"In certain cases the surgeon can, with some degree of certainty, foretell the progress of the nævus. If the nævus is uniformly compressible, soft, and highly vascular, approaching to a bright red colour, especially at the margins, it is fairly safe to predict that it will increase in size." Mr. Waterhouse advises that the surgeon should hold his hand in all nævi which are not increasing, in infants the surgeon has not a free hand here. If he does not advise operation, adv
elsewhere.

deformity that is remediable in her child. (4) In early life nævi are usually small, and easily and safely cured. (5) The spontaneous cure of a large nævus may leave, by puckering or redundant folds of the skin, far more deformity than that of an operation. Before describing the different operative measures I would remind my younger readers—(a) that there is no method suited to all cases; (β) that it is very easy, by using heroic means and doing too much, to cause needless scarring; (γ) that during the cure of large nævi in early life the patients are liable to pyrexial attacks and grave malaise. These are not at all uncommon during the cure of large nævi, even though asepsis be maintained.

Different Methods.—I shall only speak at any length of four of these—viz., excision, electrolysis, subcutaneous discission, and the cautery. By one of these, or by two combined, all nævi can be satisfactorily dealt with. Other methods will only be briefly alluded to.

(1) *Excision.*—I have used this method very largely for nearly all subcutaneous and mixed nævi save those on the face, and for many large cutaneous ones where the scar will be hidden. There is a very great probability of primary union; it is a rapid method, leaving no slough to separate, as is the case with the cautery or ligature, and needing no repetition, as in electrolysis. Two points require notice; one is the risk of hæmorrhage. This is met by working rapidly, by judiciously applied finger-pressure, by keeping wide of the nævus (if the incisions are made outside the nævus the hæmorrhage is not serious, save in large nævi in infants), and, where the bleeding will be severe, by using the method of Mr. Davies-Colley. My late colleague passed two needles, at right angles to each other, beneath the base of the nævus, and twisted around and below them a fine drainage-tube (this may be kept tight by clamping it in Spencer Wells's forceps); below all, two or three silver sutures are passed deeply. After the nævus has been removed, the needles and drainage-tube are withdrawn, and, before bleeding can occur, the sutures are quickly twisted up. The other point is the advisability of leaving any nævoid skin in the excision of a large mixed nævis. While the greater part of the diseased skin should always be removed, narrow strips left on either side will, usually, slowly take on a natural colour. The wound is carefully united with sutures of fine fishing-gut and horsehair; wire has the advantage of being quickly twisted when the hæmorrhage is free. Usually no drainage is required. Where, after excision of large nævi on parts concealed, such as the trunk and limbs, it is impossible to bring the edges of the wound together, skin-grafting by Thiersch's method (p. 233) may be employed. I would give a caution to my younger readers with regard to excision of subcutaneous nævi over the abdomen in infants or little children. In these cases there will be additional need of strict asepsis, for, at this age, the abdominal wall is extremely thin, and, if suppuration occur, a fatal peritonitis may result. In some instances of deep-seated extensive nævi of the side of the face, excision can only be used in conjunction with electrolysis. In such cases excision should, whenever possible, be employed first, before the parts are altered by the electrolysis. One more occasion when excision will, sometimes, be found useful is when a nævus has been cured by some other means and an ugly scar left—

e.g., at the root of the nose. If it be possible to get the edges together and to secure primary union, excision will, here, greatly improve matters.

(2) *Electrolysis*.—This method has the great advantage of leaving a minimum of scar* or pucker behind it, and what scar there is, is of good colour. Other advantages are that there is no bleeding, no danger, and little or no pain after the operation. The chief disadvantage is that it requires several sittings—on an average, four or five—and, as an interval of six weeks should elapse between each, the treatment is spread over a considerable time. For this reason the method is not suited to hospital patients, who, usually of limited intelligence, are ill content if the blemish is not speedily removed. With patients of more intelligence and a better rank in life, the following should be insisted upon—1. That, while electrolysis is not expeditious, it is the slow, gradual fading of the nævus which gives the best after-result. 2. That the chief object of the operator is to stop the growth, and then to wait patiently, unless the nævus re-develops or its subsidence is much delayed. Electrolysis is best suited to those nævi which are unsuited to excision, and where the cautery will leave a conspicuous scar—*e.g.*, upon the face, and especially upon the eyelids and nose. In the following account of electrolysis I shall quote from the writings of established authorities on the subject, from whom I have learnt very much.

Dr. W. Newman, of Stamford, writes (*Brit. Med. Journ.*, 1882, vol. ii. p. 248): "The cases for which electrolysis is eminently suited are superficial, dark-coloured, sluggish, vascular growths, which do not possess special or abundant blood-supply. They waste away after one or two sittings, as a matter of moral certainty. Next in order are those nævi which, agreeing with the above in their actual vascularity, yet have much more of surface-covering, and which do not, therefore, so readily declare the conditions of their blood-supply. A majority of these cases will probably be found to be quite amenable to the electric current. On the other hand, the cases in which electrolysis will not, at least as a rule, succeed, are those which are intensely vascular, which are rapidly growing, and which it is fair to conclude have more or less direct communication with blood-vessels."

Dr. J. Duncan (*loc. infra cit.*) thus described the method which he had done so much to improve: "After trying many batteries of constant current, I have reverted to the Bunsen or Smee with four to six cells of large size. In the Infirmary, where it can be prepared by others, I use the Bunsen of four cells, as giving the largest amount of chemical work with the least tension. But in private, Smee's battery with plates about 4 inches by 6, and having six cells, is most convenient. It is less dirty, has only one fluid, and is equally effective." Before operating, the poles should be tested in saline water, and only used if the evolution of gas is copious and continuous.

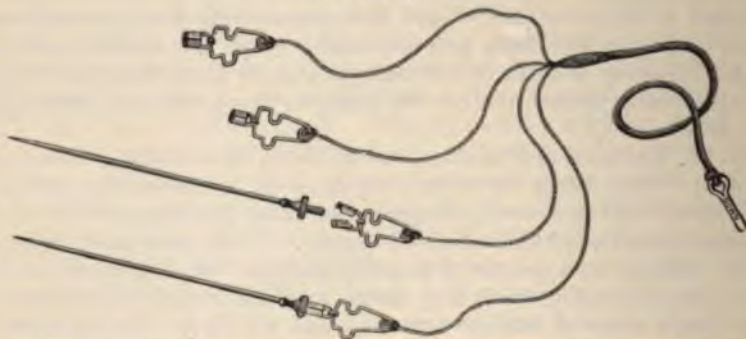
The needles recommended are those introduced by Prof. Fraser and Dr. Duncan. They should be insulated with vulcanite. The length of the exposed point should vary from $\frac{1}{8}$ to $\frac{3}{4}$ inch, according to the size of the nævus. Steel is the best material; but the positive pole, if of

* Dr. L. Marshall (*loc. infra cit.*) claims another advantage—
it does not tend to contraction in loose tissue like that of the e

at it

steel, requires re-sharpening after each operation, because it is acted on electrolytically. Both poles should be introduced, as giving most work in the least time. In small nævi they are best placed parallel, and equidistant from each other and from the sides of the tumour. In large nævi, Dr. Duncan moves them, especially the negative, from place to place, and introduces them through new punctures. If left stationary, the action rapidly diminishes after ten or fifteen minutes, on account of the slough with which they surround themselves. It is necessary to watch very closely the growing induration round each needle. It increases slightly even after the needles are withdrawn, and the action must be stopped before the skin is involved. If the needles be very slowly withdrawn while the battery is still working, so as to cauterise slightly their track, not a single drop of blood will flow, otherwise pressure should be applied for a few minutes. The nævi should then be covered with aseptic wool and collodion. In large

FIG. 147.



Electrolysis needles for use with constant current batteries with serrefine holders.
(Down Bros.' Cat.)

nævi too much must not be done at one sitting or in one place. The slough has to be absorbed, and it is better to establish several small sloughs at different parts than a great mass at one. An anæsthetic is required.

Dr. Lewis W. Marshall, of Nottingham (*Lancet*, vol. i. 1889, p. 73; *Brit. Med. Journ.*, vol. i. 1897, p. 273), advises as follows: "I always use the positive pole with one or more needles, according to the size of the growth and its situation. The needle (or needles, as the case may be) is moved about systematically to attack the growth in various parts. This is done without withdrawing the needle after it has remained long enough in one spot to produce some effect. It is wiser at first to work well away from the surface of the tumour, especially in raised nævi which are very florid, to avoid risk of destroying the thin covering. The circuit is completed by attaching a rheophore to the negative pole; by this we avoid an unnecessary puncture, and I find that the process is equally effectual. I have not yet succeeded in finding a good means for insulating needles, and the scar left by the negative needle is brown and very disfiguring. I also prefer to use the positive instead of the negative pole, because it is slower in its action, and therefore less likely to lead to sloughing, and the bleeding

on withdrawal of the needle is much less troublesome.* The number of cells used varies somewhat, but my usual custom is to commence with five Leclanché cells (Silvertown Battery Company), and increase according to the effect produced. Ten cells are generally sufficient, but in deep subcutaneous nævi I have applied twenty cells. The amount of tension caused must be very carefully gauged, cutaneous nævi being capable of standing very little. Change in colour to a dusky hue is a good guide to judge when it is requisite to stop the current. On withdrawal of the needle all that is required is to rotate it before pulling to free it, and then paint the orifice with collodion."

Dr. H. Lewis Jones, who has had large experience at St. Bartholomew's Hospital, describes his methods in the *St. Bartholomew's Hospital Reports*, vol. xxx. p. 206. He considers the "unipolar" method the most useful. "Needles of platinum having been connected with the negative pole, the circuit is completed through the patient's body by means of a well-moistened pad attached to the positive pole and placed underneath the patient's back or hips. Small currents are employed, and the nævus is done gradually.† The reason why this plan is preferred is because it gives the operator one set of needles only to manage; the density of the current in the nævus is more easily distributed; the changes produced at each of the needles are alike to one another, and there is little or no bleeding after withdrawal of the needles. Further, the systematic use of the same pole makes it easier to recognise the appearances which indicate that enough has been done, so as to stop the electrolytic action before the stage of complete destruction and sloughing. The objections to the unipolar arrangement of needles are that the current traverses the body of the child, who may, therefore, be affected by electric shocks, and the positive pad, if not carefully managed, may produce an undesired electrolysis in the wrong place. The first of these objections is not serious unless the nævus be situated on the head, and even then with proper care it becomes slight, if one remembers that the needles should be inserted and removed singly and gradually, and the full strength of the current turned on after the insertion of the needles, and turned off before they are all removed. The other danger—that of electrolysis at the seat of the positive pad—can be guarded against by strict attention to the pad and conducting wire; both must be completely covered by moist material, as the smallest portion of uncovered metal will produce destructive effects at the place where it touches the skin." The bipolar method, in which both the poles are inserted into the nævus, is carried out by Dr. Jones by means of his fork-electrodes,

* Another advantage of the positive pole is that here, as in aneurysm, it produces a clot which is fairly firm and useful in organising; the negative pole, on the other hand, yielding one which is soft and frothy, and of less value.

† "It may be taken as a principle of the electrolytic treatment that the current should not be pushed to such an extent as to cause the nævus to slough. It follows as a rider to this that electrolysis can very seldom be used so as to get rid of a nævus at one operation, unless it is quite a small one, for where this is attempted the result is almost certain to be a slough, and should be regarded as an unfavourable termination. If the nævus is very small, that is to say under a fifth of an inch in diameter, it may be completely destroyed in one sitting."

in which two to five needles can be arranged, firmly, parallel to one another, thus easily controlled and evenly distributing their action on the tissues. If the needles are used in the ordinary way, care must be taken to keep them parallel, not to allow their points to come in contact, thus producing needless shock, and to keep them at regular distances from each other, from the periphery to the centre of the nævus, so that the whole of the nævus, centre and periphery alike, may be acted upon. If the needle-points converge to, and thus the current is concentrated in, the centre of the nævus, sloughing is likely here, while the periphery will escape. As to the strength of current used, Dr. H. Lewis Jones advises as follows: "The best way of specifying the current is to take into consideration the number of needles used, and to say that for every inch of needle in the nævus, twenty to thirty milliamperes is sufficient. Thus, if four negative needles are inserted to a quarter of an inch apiece, the total current may be twenty or thirty milliamperes." The needles used may be of platinum, one advantage of which is that they may be attached to either pole. The only objection to them is the difficulty of rendering them really sharp. If steel or copper needles are used they must be attached to the positive pole. The needles should be isolated with vulcanite for a full half of their length, otherwise sloughing will occur at the point of their puncture. Before use the needles should be boiled. When introduced their points must not be allowed to approach the surface of the nævus too closely, or sloughing and, later on, sepsis will occur. The progress of electrolysis is best judged by the induration which takes place, also by any discoloration at the points of entrance of the needles. A greyish spreading zone here indicates that it is time to withdraw and re-insert the needle. Blackening at any part denotes that sloughing will ensue there. Before the needles are withdrawn the current should be shut off, but not abruptly. The only dressing needed is a little salicylic or iodoform wool, kept on with iodoform and collodion till the punctures are healed.

(3) *Subcutaneous Discission*.—This is an excellent means of obliterating a nævus without scarring, introduced by Dr. Marshall Hall. A cataract-needle or a fine tenotome is passed from a point about a line from the margin of the nævus to the opposite extreme edge of the growth. The needle is then withdrawn almost to its point of entrance, and pushed again through the nævus at about $\frac{1}{16}$ inch from the line of the first puncture, and so on till the lines of puncture take a fan-like shape. The number of times which the needle is passed will vary, according to the size of the nævus, from ten to forty. Each passage must be just removed from the last. Should the needle penetrate the skin, pressure must be applied. This method is best adapted to subcutaneous or mixed nævi of moderate size. In nævi of the lids, where removal or destruction of the tarsal plates will tend to scarring, this method deserves a trial, when electrolysis is not at hand. After a few weeks repetition may be needful. For superficial nævi, *e.g.*, of the lids or tip of the nose, scarification with a fine and sharp knife (p. 426) often gives good results.

(4) *Cautery or Ignipuncture*.—Paquelin's cautery is usually employed, the large blade at a dull cherry-red heat being carefully wiped over a cutaneous nævus, and the fine point used for the subcutaneous

ones. This is made to penetrate the skin at one spot, and then made to traverse the nævus in several directions from the one puncture. It is effectual, but the more I saw of it the less I liked it, owing to the large scars it leaves. Thus the black sinus or sinuses left after the operation with a red margin of scorched skin suppurate and heal tediously, and with much disfigurement in exposed places. Furthermore, while the slough is being detached the health of an infant or little child often suffers considerably. The small-sized Paquelin's cautery, recently introduced, is greatly to be preferred to that in ordinary use, but best of all is a cautery-battery with the fine platinum points and porcelain burners which any electrician can supply. If, in hospital practice, the surgeon arranges for his nævus cases to attend on one day, there should be no difficulty about the battery being ready. The amount of scarring left is far less than that by the Paquelin's cautery. No anæsthetic is required with either in infants, the pain being momentary. I will take the opportunity here of drawing attention to a most useful warning by Mr. Waterhouse (*loc. supra cit.*), which applies to treatment of nævi by ignipuncture and caustics: "In mixed nævi it is necessary to procure destruction of the sub-cutaneous portion of the growth, and the cure of the cutaneous part as a rule follows. Times without number have I seen cases in which the treatment adopted has been destruction of the skin portion with caustics. This has resulted in ugly scarring, and the sub-cutaneous portion of the growth has not been in any way influenced for good." A very simple form of cautery for those stellate patches which appear on girls' faces long after infancy, "spider nævi," is supplied by a needle heated or dipped in nitric acid. An anæsthetic should be given. Another excellent means for healing minute nævi is to make a puncture with a tenotome, and apply for a few seconds a finely pointed stick of silver nitrate.

(5) *Application of Caustics*—*e.g.*, *Sodium Ethylate and Nitric Acid*.—These are suitable for cutaneous nævi. *Ethylate of sodium*, introduced by the late Sir B. W. Richardson, is the one generally used as being less painful.* It should be applied daily for two or three days; a crust then forms: when this drops off the nævus will be found to be cured if the application has been sufficient. *Nitric acid* is much more powerful; careless use of it may produce most odious scars. Whatever caustic is used, it is well to smear the parts around with vaseline, and the pointed wood or glass rod used should carry only just enough of the acid, and none to drop about.

(6) *Scarification*.—I have already spoken of this method above. It may, also, be employed for any cutaneous part of a nævus which is left in a florid state after other treatment, or for port-wine stain, in the same way as advised at p. 426.

(7) *Collodion*.—This may be tried in tiny cutaneous nævi. These can, however, be better treated otherwise. In nearly all other nævi it is a placebo, but not always a harmless one, as it wastes time.

(8) *Vaccination*.—This is not to be recommended. From a very large number of cases which I have seen where this has been used, I

* The amount of pain is disputed: by some there is said to be very little at the time of application and afterwards. I have not found that this is the case.

am of opinion that it very rarely cures the nævus, while the vaccination is not reliable.

(9) *Ligature*.—I have long ago entirely abandoned this, owing to its painfulness, its production of a slough and large scar, and the great risk there is that parts of the strangled mass may escape obliteration.

(10) *Injection*.—This, as usually performed with a preparation of iron, is extremely risky, and should never be made use of unless the nævus is securely surrounded, as with a ring-forceps. Several cases suddenly and instantaneously fatal from thrombosis and embolism* have occurred, and a few have been recorded (*Lancet*, 1867, vol. ii. p. 191). I well remember witnessing one in my student days. The late Mr. W. M. Coates, of Salisbury, a surgeon of wide experience, used iodine injection with much success (*Brit. Med. Journ.*, 1883, vol. ii. p. 319). About half a drachm of the undiluted tincture is thrown in slowly by means of a Wood's syringe with a very fine needle. By moving the point, the tincture is thrown into every part. On withdrawing the needle, pressure on the puncture is required for a few moments. The nævus hardens at once and slowly disappears. No scarring results. Mr. Coates considered the treatment by iodine injection quite free from any risk of thrombosis.

If injection is to be employed, pure carbolic acid should be made use of, a minim being thrown in at each puncture, the part being invariably first shut off safely from the general circulation by ring or padded forceps, or by the plan of temporary strangulation by the ligatures figured at p. 270 in part i. of Cheyne and Burghard's *Manual of Surgical Treatment*.

Port-Wine Stain.—This troublesome form of cutaneous nævus is best treated by the careful use of caustics, linear scarification, or the employment of a platinum cautery kept at a white heat. This should barely touch the surface of the stain. Whichever method is used, care must be taken not to destroy too much—*e.g.*, no more than the epidermis and superficial layer of the rete mucosum—in the cases where the stain is thinnest and most diffuse. Cicatrisation will do the rest. Here especially, it is very important to maintain asepsis, *e.g.*, with iodoform or salicylic wool, or iodoform and collodion.

Large Hairy and Pigmented Moles.—The methods at hand in these rare but very troublesome cases are piece-meal excision and grafting, electrolysis, scarification, and the use of nitric acid. Where they descend from the forehead and encircle the eye, great care must be taken not to destroy the tarsal plates. Where a large isolated patch occupies one cheek, piece-meal excision and grafting, or complete excision and a Wolfe's graft (p. 235), or one pedunculated from the arm, should be tried.

* Another unfortunate result is alluded to in the footnote, p. 453.

CHAPTER V.

EXCISION OF THE EYEBALL.

EXCISION OF EYEBALL.*

Indications.

- i. New growths—*e.g.*, glioma of the retina, melanotic sarcoma of the uveal tract.
- ii. In the following cases of injury and its results:
 - (a) The eyeball ruptured and collapsed after a blow.
 - (b) A large, jagged, foreign body in the eye—*e.g.*, a bit of metal, not removable without inevitable disorganisation.
 - (c) If (Nettleship's *Diseases of the Eye*, p. 142) the wound, lying wholly or partly in the dangerous region,† be so large and so complicated with injury to deeper parts that no hope of useful sight remains.
 - (d) If, though the wound be small, it lie in the dangerous region, and have already set up irido-cyclitis.
 - (e) Where a small foreign body—*e.g.*, a shot glancing in cover-shooting—not removable by an electro-magnet, gradually sets up inflammation and shrinking of the eye.
 - (f) When there is a wound in the dangerous region complicated with traumatic cataract.
 - (g) When traumatic cataract has been set up by a wound which is wholly corneal, and therefore out of the dangerous area, and yet severe iritis and pan-ophthalmitis come on in spite of treatment.
- iii. As part of an operation for rodent ulcer which has extensively involved the conjunctiva (p. 434).
- iv. As part of an operation for removal of orbital tumours—*e.g.*, a glioma or sarcoma which has ruptured the sclerotic, rodent ulcer, scirrhus, sarcomatous, bony growths, &c.‡

Operation.—The chief object is to remove the globe alone, whenever this is possible, leaving the muscles to coalesce and form a stump on which the artificial eye may be supported and be movable. As much conjunctiva as possible should be left.

The surgeon, standing in front, having inserted a spring-speculum between the lids, snips with blunt-pointed scissors through the ocular

* As the general surgeon may be called upon to perform this operation at any time, and as it should always be practised on a dead body, it is included here.

† A zone nearly a quarter of the cornea, extending from the limbus and rounding the cornea.

‡ For an excellent account of the operation, the reader is referred to Mr. Lawson's article *Diet. of Surg.*, vol. ii. pp. 117 et seq.

conjunctiva close to the cornea and all round it, using toothed forceps to lift the conjunctiva, and leaving enough at one side to hold on by the forceps during the next step. This is to open freely Tenon's capsule, and catching up each rectus tendon (beginning usually with the external rectus) with a strabismus-hook, to divide them close to the sclerotic, leaving the cut end of the external rectus long, in order to draw the eyeball forcibly inwards. The superior and inferior rectus are then cut, and the speculum pressed back into the cavity of the orbit so as to make the eyeball start forwards. The scissors, blunt-pointed and slightly curved, are now passed back to feel for the optic nerve, which may be known by its toughness and thickness, and which is now severed with one clean cut. The eyeball being drawn forwards with a finger, the oblique muscles and any remaining soft parts are to be cut close to the globe. Pressure is then to be applied firmly for a few minutes, and for the first ten hours pressure with sterilised aseptic pads and a bandage should be maintained to prevent temporary but troublesome hæmorrhage.

In the case of a new growth—*e.g.*, glioma—the optic nerve must be divided as far back as possible. The scissors, slightly curved and long enough to reach to the back of the orbit, are introduced on the inner side, and the nerve either cut as far back as is possible before the globe is removed, or, after this is done, the nerve is dissected out and a fresh slice taken.

Where there is any suspicion of growth, as in a glioma of the optic nerve, being left behind, zinc chloride paste should be applied, as at p. 434, or formalin on strips of gauze may be substituted.

Owing to the early stage at which dissemination of intra-ocular sarcomata takes place, and to the tendency of gliomata to creep backwards along the optic nerve towards the interior of the cranium, the prognosis very largely depends upon the earliness of the extirpation. On this account it should be remembered that the earliest symptoms of these growths—*viz.*, impairment of sight from partial detachment of the retina by the pressure of the growth behind it—should be most carefully tested in suspicious cases, this impairment of sight being not usually noticed by the patient, save accidentally on closing the sound eye, unless the growth originates near the yellow spot. If later evidence is waited for, such as evidence of tension and pain, dissemination or recurrence is most probable, while the growth will very likely have perforated the eye, and the severer operation of clearing out the orbit will be required.

The following questions will very likely arise: If there is evidence of general dissemination of the disease, is it expedient to remove the eye, or, if this be insufficient, to clear out the orbit as well? In most cases the answer will be in the affirmative, in order to save the patient pain and the misery of the protruding and ulcerating mass.

If the disease has recurred, is it any use again to attack it? Each question here must be decided by itself. The answer will mainly depend on the amount and depth of the recurrence, and on the completeness of the first operation. Thus, if the eye only was removed at first, it may be wise to clear out the orbit thoroughly.

In a few most distressing cases in children it is well known that both eyes are attacked. The question of operating on the second eye must

now be faced. Mr. Collins (*Trs. Ophth. Soc.*, vol. xvi. p. 142) has recorded four cases, in each of which three years had passed since the enucleation of the second eye, and the patients were alive, with no sign of recurrence. Mr. Lawson* held that if both eyes are affected, both should be excised, providing that the sight has already been destroyed. He had, on many occasions, removed the second eye to procure temporary relief from the excessive pain induced by the over-distended globe, and when there had not been the slightest prospect of curing the disease. In each case the operation gave immediate and perfect relief.

The following operations will occasionally be called for.

Clearing out of the Contents or Exenteration of the Orbit.—The following is an instance of the cases in which this operation will be justified.

In November, 1903, a man, æt. 38, who had the eyeball removed for sarcoma elsewhere in the previous July, came under my care for persistence of the disease. The left orbit was occupied by a fungating, bleeding, sloughy mass; the eyelids were not involved, and no infiltration of glands could be made out. An incision having been made all round the orbital margin down to the bone by means of an elevator, the periosteum was carefully stripped up from the entire interior of the cavity back to its apex. The optic foramen was enlarged with a small gouge, and then with fine, blunt-pointed scissors pushed in as far as possible the optic nerve was divided. The entire mass then came away with its coat of periosteum. The section of the nerve appeared quite healthy. The bones themselves did not appear involved. The frontal sinus was explored and demonstrated to be free from disease. The cavity was packed with strips of sterilised gauze wrung out of pure formalin, one strip being carefully carried into the enlarged optic foramen. These were removed in thirty-six hours, leaving the dry, black, odourless sloughs so characteristic of the use of formalin. The recovery was without interruption save for severe pain during the first forty-eight hours. The patient was seen by me for nearly two years, and there was no reappearance of the disease. During the first twelve months the above-mentioned sloughs remained little altered, then they gradually became detached and were removed, leaving a healthy, granulating surface. During nearly two years the man was able to continue his work as a shepherd in Kent. During the detachment of the sloughs carbolic acid oil was applied, the patient's wife being directed to soak strips of lint with clean hands in a clean covered vessel, morning and evening. In January, 1906, I learnt that the opposite eye was attacked in September, 1905, the patient becoming blind and dying in two months with paraplegia and convulsive attacks. There was no evidence of reappearance of disease on the left side. The deformity was, of course, considerable, but when the malignancy of sarcoma of the eyeball, its 'speedy' reappearance after the first operation, and the interval of nearly two years in which the patient remained well are considered, the result, which I hold to be entirely due to the use of strong formalin, may be considered satisfactory.

Intradural Growths of Optic Nerve Itself.

Mr. H. P. Bennett, surgeon to the Newcastle-on-Tyne Eye Infirmary, reports one of these rare cases (*Brit. Med. Journ.*, 1905, vol. i. p. 1041). The patient was a boy, æt. 11. From the perfect mobility of the eye and its projection directly forwards, Mr. Bennett had no doubt that he had to deal with a tumour situated within the muscular cone, and from the early loss of sight, with probably a growth of the optic nerve. The eye was removed with about 1.3 cm. of apparently normal nerve attached to it. On inserting a finger into the orbit, a large growth could be felt extending right down into the optic foramen. In order to remove the whole of this mass a small gouge was inserted into the apex of the orbit, and the whole of the growth was removed with 1 cm. of healthy-looking nerve at the posterior end; in fact, the nerve was partly torn away at or very near the chiasma. The growth was a fibroma. The patient was well about six months later.

* *Dict. of Surg.*, vol. ii. p. 124.

Temporary Resection of External Orbital Wall.—Kronlein, in order to avoid the sacrifice of healthy eyes, and to enlarge the very limited field between the eyeball and the outer wall, was the first to propose the above method as a means of obtaining access to the structures behind the eyeball. Domela has collected (*Revue Med. de la Suisse Romande*, 1902, vol. xxii. p. 833) forty-five cases in which this operation was performed and has analysed the results. The conditions calling for it were sarcoma, angioma, cysts, endothelioma, neuroma, adenoma, osteoma, growths of the optic nerve and sheath, injury, pulsating exophthalmos, and retro-bulbar suppuration.

A curved incision is made with its convexity forwards in the temporal region commencing at the anterior part of the temporal crest, 1 cm. above the upper margin of the orbit, extending along the outer orbital margin almost as far as the outer canthus and ending on the zygomatic arch midway between the outer canthus and the auditory meatus. It is carried down through the skin, aponeurosis and muscles, but, along the orbital margin, only divides the periosteum. The periosteum is next separated with a rugine from the outer orbital wall as far back as the spheno-maxillary fissure below and a few mm. behind the spheno-malar suture above, and is partly retracted along with the orbital contents. The exposed outer wall is now divided along the following three lines: (1) Above, from the external orbital process of the frontal bone horizontally backwards. (2) Posteriorly, from the posterior end of this incision obliquely into the spheno-maxillary fissure. (3) Below, from the base of the orbital process of the malar bone horizontally backwards to the anterior extremity of the spheno-maxillary fissure. The bony fragment with all its adherent soft parts is displaced outwards and backwards, the orbital periosteum is incised horizontally, the external rectus easily distinguished and the retro-ocular space well exposed. At the conclusion of the operation the orbital periosteum is sutured, the bone replaced, and the wound sutured. Of the forty-five cases collected by Domela one patient died from an invasion of the cranial cavity soon after the operation. In six others it was needful to completely remove the contents of the orbit. In the remaining thirty-eight no atrophy of the eyeball followed, even when it was necessary to divide the optic nerve. In many cases vision was much improved. The only inconvenient effects are said to be temporary anaesthesia of the cornea, diminution of the mobility of the eyeball, and external strabismus.

CHAPTER VI.

OPERATIONS ON THE NOSE.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE—
ROUGE'S OPERATION—REMOVAL OF NASAL POLYPI
—ADENOIDS OF NASO-PHARYNX.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE
(Figs. 148 to 153).

THESE operations will be considered under the following headings: (A) those for "saddle-nose" where the bridge is lost; (B) those for complete and (C) those for partial restoration. The injection of paraffin will be found described at p. 463.

Indications.—When the patient is healthy and of good vitality; when the cause of the destruction—viz., lupus, gunshot or other injury, syphilitic ulceration congenital or acquired, new growth (*e.g.*, epithelioma or rodent ulcer) necessitating removal—is not only checked but soundly healed.*

Thus, when lupus has been cured, and still more in the case of syphilitic ulceration, it will be well to wait six months at least after the disappearance of the disease.

A. Operation for Saddle-nose.—This partial rhinoplasty will be taken first and by itself, as it is one of the most frequently indicated, and as it is one which gives the best results. The condition presents itself in varying degrees of deformity. In a typical case the entire bridge is deeply depressed, while the cartilaginous portion with the subjacent part of the septum is tipped upwards and forwards by cicatricial contraction, the nostrils looking forwards instead of downwards. It may follow syphilis acquired or congenital, depressed fracture or suppuration, and necrosis after injury. That due to depressed fracture is obviously likely to give the best results. Whatever the cause, healing must be complete before any operation is attempted. Operative steps here will probably be largely replaced by the use of paraffin.

The operator has two indications before him: (1) to replace and to retain in its new position the cartilaginous part of the nose; (2) to restore the bridge. The following account is given in detail, as this operation will be found to give the best basis of the method of complete rhinoplasty. Most of these have now only an

* In Sir W. MacCormac's case, the operation was performed in infancy, after the

and do not give permanent results. The credit of the success of the operation for saddle-nose must be given, in the first and chief place, to König. His method has been improved by different operators, *e.g.*, Israel and Watson Cheyne.

The parts concerned in the operation are rendered as sterile as possible. By a curved transverse incision at the deepest part of the depression which enters the nasal cavity and is carried with sufficient freedom through all adhesions and what is left of the bony framework (with a fine saw or a chisel) and through the cartilaginous septum sufficiently to liberate the soft parts of the nose below, these are replaced so that there is no tendency for them to spring back into the place where the tip of the nose should naturally be. In cases where the skin over the upper two-thirds of the nose is sound and sufficient a vertical incision is made from the root of the nose down its centre to where the curved transverse incision was made. At the upper end of this vertical incision two slightly curved ones with the convexity upwards are carried outwards for about an inch at first, and by this means two lateral flaps are raised off the centre of the nose. They should not be raised more widely at this stage as this step would cause needless and troublesome hæmorrhage.

The bridge to the nose is then made by taking a flap from the forehead. Two incisions going down to the bone beginning about half an inch above the root of the nose and each about one-eighth of an inch from the middle line, are carried upwards to the roots of the hair if needful. A transverse cut of similar depth joins the upper ends of these incisions. With a narrow chisel introduced first at the sides and then above, and sloped sufficiently, the flap of skin and external table of the frontal bone is raised from the diploë. When the lower end of the flap is reached the bone is broken across here. König now inverts the flap before transplanting it, so that the shell of bone forms the outer and the skin the inner surface of the nose, and brings down a skin flap in the usual way from one side of the forehead which is placed on the raw surface of the first flap. This method may be required where the soft parts over the bridge of the nose are much altered; it obviously entails much more scarring than that of Israel and Watson Cheyne where the second flap is taken, as described below, from the nose itself. The skin upon the deeper surface of the flap is shaved off where this is needful in order to cause it to adhere to the remaining tissues of the bridge, which are also, in their turn, refreshed. In either case the narrow flap from the forehead must be long enough for its free edge to be stitched with fine sterilised catgut to the tip of the nose in its normal position without any tension whatever. This is sometimes difficult to ensure when the hairs grow low down upon the forehead. If, to secure the above object, the two incisions on the forehead are prolonged downwards, care must be taken not to imperil the vascularity of the flap.

The two lateral flaps which were raised sufficiently in order to allow the frontal strip to be placed in position on the bridge of the nose are now carefully raised by curving outwards the two incisions at their upper extremities. Troublesome bleeding is often met with as the flaps are raised. When sufficiently raised they are united with sterilised horsehair and very fine salmon-gut sutures in the middle line over

the raw surface of the median frontal strip which has been reflected downwards.

The incision in the forehead is sutured and should leave a linear scar. In about a month's time the base of the reflected frontal strip is divided, and any redundancy and folds remaining are removed by suturing the divided base into place after small elliptical portions of skin have been removed.

Messrs. Watson Cheyne, C.B., and Burghard (*Man. of Surg. Treat.*, pt. v., p. 155) recommend the following additions to the above steps. "To keep the tip of the nose in position, we have found it a good plan to take a long splinter of a rabbit's femur,* and to stick one end of it into the tissues at the root of the nose, and the other into the cartilaginous portion; this forms a prop sufficiently long to keep the parts in position." As the newly-formed bony bridge tends to sink downwards as healing occurs and, as a rule, will not be high enough, they advise the adoption of the following. "After healing has occurred, we have been able to heighten the bridge to the required extent by turning aside the skin flaps again, and introducing pieces of bone removed from the femur of a newly-killed rabbit in sufficient quantity to raise the bridge to its proper level." Care must be taken not to reopen the nasal cavity at the second operation, otherwise infection will occur with risk of necrosis of the bone used.

B. Operations for Complete Restoration.—I have described several operations, so as to suit the varying conditions met with, but

* The following account of the details of this most important step is taken from Mr. Watson Cheyne's paper (*Clin. Soc. Trans.*, 1899, vol. xxxiii. p. 218).

"The patient, æt. 18, had received a severe injury to the bridge of his nose (? fracture) when twelve years old, this being followed by suppuration from the nose, and, during the next few months, by discharge of portions of the nasal bones. The result was loss of the bony bridge. There was practically no bony bridge present; some rough bone, no doubt of periosteal origin, could be felt covering the space between the two maxillæ in the situation of the nasal bones. There was, fortunately, very little tilting forward of the tip of the nose, and it was not necessary at the operation to cut into the nasal cavity to rectify this deformity. The patient having been anaesthetised, a curved incision with the convexity to the right was made, beginning above rather to the left of the middle line at the root of the nose, and terminating below rather to the left of the middle line about half an inch below the commencement of the cartilage of the nose; the convexity of the curve at its centre extended on to the cheek. The incision at the upper part went down to the bone, and at the lower part to the nasal cartilage. The flap was then turned over to the left, an attempt being made to peel off the periosteum from the nasal bones, which, however, failed owing to the great irregularity of the new bone. While the bleeding was being arrested by pressure, a rabbit was killed by chloroform, immersed in bichloride of mercury solution (1 in 2000) to fix the hair, and rapidly skinned by one of the dressers. One of the thighs being then disarticulated at the hip, the soft parts over the femur were detached, the periosteum being left, and with a pair of cutting pliers the bone was split up longitudinally into several fragments. The wound being now uncovered, a fragment, about two inches in length, was first inserted into the nasal cartilage at the lower part, pushing down the tip of the nose, and then wedged against the frontal bone at its upper part. Four or five smaller fragments were now laid around this till the necessary height for the bridge was obtained. The skin flap was then replaced, but before it could be made to meet it was necessary to undermine it well towards the left side. The wound healed by first intention, but ~~the~~ ^{on the} operation a little glairy fluid was let out at the upper part. The later, was excellent."

it is increasingly rare to meet with cases requiring complete restoration of the nose. The first three of the following will be found most useful.

1. **Methods by double or superimposed flaps, based upon that of König.**
2. **Keegan's Operation** (Figs. 148, 149).
3. **Syme's, from the Cheeks** (Figs. 150, 151).
4. **The Indian or Frontal.**
5. **The Italian or Tagliacotian.**

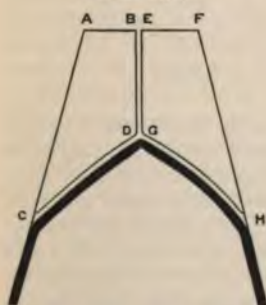
Before deciding which operation he will make use of in restoring the nose, the surgeon will investigate the following points: How far is the bony framework of the nose destroyed? If the cartilages, septum, vomer, ethmoid, and nasal bones are much removed, however well made the single frontal flap, and however skilfully it is adjusted, it will tend, after looking extremely well at first, to sink down to the level of the cheeks. The final result of complete rhinoplasty is rarely satisfactory. In Tillmann's words, "The nose is at first very good, but it soon shrinks. The art of rhinoplasty consists in making a nose with a good profile, long, high, and pointed; but this, as a permanent result, is seldom attained." If he proposes to take flaps from the cheeks, the surgeon must examine how far these are plentiful, and free from old scars. So, too, if the forehead is to furnish the flaps, how far it is a capacious one and free from hairs.

1. Methods by Double or Superimposed Flaps, based upon that of König.—Owing to the ultimate disappointment which is certain with the single flap, an operation based on the method which has been given in detail above is always to be preferred. The central skin and bone forehead flap must be cut much broader. Rotter says 3.5 cm. broad. It should be turned down at its base so that the skin lies internally. After three or four weeks it is skin-grafted, or covered with a flap taken laterally from the forehead. If the superficial surface be extensively bony the bone is divided longitudinally on either side with a fine, sharp saw, so that the central part forms the bridge and the lateral only support it. But, as a rule, the bone splinters too easily for this step to be feasible. As the deep surface of the flap is turned forwards any bone that exfoliates is easily removed. A columella must be made subsequently (p. 460). This should always be as narrow as possible, otherwise breathing will be interfered with. Many other details will be gathered from the account of the methods which follow.

2. Keegan's Method of Rhinoplasty.—This method has been introduced (*Lancet*, vol. i., 1891, p. 419) by Surgeon-Major Keegan, whose name is so well known in relation with lithotrity. As Residency-Surgeon for many years at Indore he had ample opportunities of performing rhinoplasty—slicing off the soft parts of the nose being a very common mutilation in India, especially in the hands of jealous husbands. Such cases are most favourable for operative measures, the patients being young and healthy, and the bridge of the nose left. It will be seen that superimposed flaps are used. "The patient having been fully anaesthetised, the cavities on both sides of the septum are plugged with pledgets of wool, to which sutures are attached. The operation is begun by carrying two converging incisions from two points slightly external to the roots of the *alae nasi* to two points about three-quarters of an inch apart on the bridge of the nose, where a pair of spectacles would rest. These two points are now joined by a horizontal incision. This horizontal incision is bisected, and a perpendicular incision is drawn downwards from the point of bisection nearly as far as where the nasal bones join on to the cartilage of the nose. In other words,

this perpendicular incision follows the course of junction of the nasal bones, but is not carried down as far as their inferior borders. The skin and tissues are now dissected from off the nasal bones from above downwards in two flaps, A B C D and E F G H, as in the appended diagram (Fig. 148). The two inferior borders of the flaps, viz., C D and G H, are not interfered with, and constitute the attachment of the flaps to the structures and tissues which clothe the inferior borders of the nasal bones where they join on to the cartilage of the nose. If these two flaps are reflected downwards, so that their raw surfaces look forwards and their cutaneous surfaces look backwards, it will be found that they overlap in the centre. The surgeon has, therefore, a redundancy which he can utilise a little later on, when he has raised the flap from the forehead. He now proceeds to do this. A piece of brown paper rendered adhesive, corresponding in outline with the flap (Fig. 149) considered suitable to the case in hand, is stuck firmly on to the forehead in a slanting direction. And then a very sharp knife is run round the border of the paper. The paper is now removed, and the flap is quickly raised from the forehead. This flap should embrace all the tissues down to the periosteum, and should be subjected to as little handling as possible. The sides of the gap now left in the forehead are approximated as quickly as possible with horsehair sutures, and it is surprising how small a raw surface is

FIG. 148.



Keegan's method of rhinoplasty.

FIG. 149.



left behind* on the forehead if the approximation of the sides of the gap be judiciously and expeditiously carried out. Attention is now directed to preparing a nidus or bed for the reception of the column, and this does not require any description. The two flaps, A B C D and E F G H, which have been already raised from off the nasal bones, are now reflected downwards, and, as they overlap in the centre, two triangular-shaped pieces are cut away, and placed in the middle of the gap left in the forehead, in order to expedite the healing of the frontal scar. The forehead flap is now brought down over the nasal bones, and rests inferiorly on the two reflected flaps, A B C D and E F G H, which have been already raised from off the nasal bones. The raw surface of the frontal flap, inferiorly, lies on the raw surfaces of the two reflected nasal flaps, and the nostrils of the newly formed nose are therefore lined inside with the skin of the reflected nasal flaps. The free inferior margins of the forehead flap and the nasal flap are now brought together by horsehair sutures. The columnar portion of the forehead flap is now fixed in the bed prepared for it by sutures, and the two original incisions drawn from the root of the *alae nasi* on either side to the bridge of the nose are now deepened and bevelled off for the reception of the sides or

* Any such r

be grafted.

lateral margins of the forehead flap. The lateral margins of the forehead flap are most accurately attached, by means of horsehair sutures, to the bed prepared for them. Two pieces of drainage-tubing are inserted in the newly formed nostrils. If the root or pedicle of the new nose is sufficiently broad and is not dragged upon, and the angular artery has not been wounded, then all will go well, and there need be no fear of sloughing. I allow a fortnight to elapse before dividing the root of the new nose, and, in doing so, I cut a wedge-shaped slice out of the root, so that the new nose may not be parrot-shaped. As the inside of each nostril is clothed with skin, the drainage-tubes may be discarded after ten days."

3. **Syme's, from the Cheeks** (Figs. 150, 151).—This method is described by its inventor in his *Observations in Clinical Surgery*, p. 56. Besides doing away with a more conspicuous frontal scar, it is claimed that this method enables a nose thus constructed to have its sensations in correspondence with the part from which it was derived. To counterbalance the above is the future shrinking of the flaps.

The following drawings show the shape of the flaps, and the manner of their adjustment.

FIG. 150.



(Syme.)

FIG. 151.



(Bell.)

New flaps of the shape given in Fig. 150 are marked out on the cheeks with their conjoint pedicle above at the root of the nose, between the two inner canthi, extending so far downwards and outwards upon the cheek as to secure sufficient amplex for the new nose, according to careful measurements already taken. The old nose being got ready by careful paring, the flaps thus marked out are dissected up and united in the middle line by three or four sutures, while the outer margins are fixed on each side to the raw surface at a proper distance from the nasal orifice. Mr. Bell* advises that if any part of the old septum remain, it should be made very useful as a fixed point, a straight needle being thrust through one flap close to its outer lower edge, then through the septum, and out at a corresponding point of the other flap. The edges of the wounds left in the cheeks can generally be partially united by sutures of silver wire or fishing-gut; and the triangular portion, which must be left to heal by granulation, proves an advantage, as by its depression it enhances the apparent height and prominence of the new organ. The cavity of the new nose should, as long as is needful, be kept at first gently supported and distended by drainage-tubes drawn over pieces of catheter, through which the patient can breathe.

4. **The Frontal or Indian Method.**†—This method has been used when the soft parts of the cheeks are insufficient, when they are too cicatricial, or when an operation making use of them has failed. Its chief objections are the large frontal scar, and the liability of the single flap, though abundant and prominent at first, to shrink and fall in later on.

A piece of thin gutta-percha or leather, sterilised by sufficient immersion in 1 in 20 carbolic acid, is so cut that, when folded, it is of suitable shape and size for the new organ; it is then laid, opened out, upon the forehead, and the dimensions marked out with an aniline pencil or tincture of iodine. The flap thus drawn should be of pyriform shape, and, owing to the retraction of the skin, should measure a quarter of an inch more

* *Manual of Surgical Operations*, fourth edition, p. 176.

† Introduced into European surgery by Mr. Carpie in 1816.

than the model in every direction. The average dimensions of the flap were thus given by Sir J. E. Erichsen (*Surg.*, vol. ii, p. 608): When the whole nose requires restoration, it is usually necessary to make it about two and a half to three inches long, and from three to three and a quarter inches wide at its broadest part.

For the frontal flap, thus mapped out, a bed is now prepared by paring the old nose into a raw triangular surface; in doing this the knife must be used obliquely, cutting from without inwards towards the middle line, so as to leave a grooved surface sloping inwards. The warning of Erichsen (*loc. supra cit.*, p. 609) should here be remembered, not to remove the parts too widely, lest the cheeks later on retract and flatten out the nose. The bleeding being arrested by sponge-pressure, torsion, leaving on Spencer Wells's forceps (but not in this case by ligature), and covering over the raw surface with sterilised lint and hot boracic-acid lotion, the frontal flap previously marked out may now be raised. This is done by running a scalpel down to the periosteum, along the traced line, taking care that the pedicle be sufficiently long to bear a little twisting, and sufficiently broad and thick to secure the presence of one if not both of the frontal arteries. To avoid any risk of stoppage of its blood-supply, and sloughing, it is well to place the incision for the pedicle a little obliquely, with one side descending a little lower than the other—viz., on the side to which the flap is to be twisted. Where the level of the hairy scalp admits of it, this flap should lie a little obliquely, the tension being thus lessened. Where necessary, the flap may be taken transversely above one or other eyebrow; but the objection to this is, that the retraction of the scar upon the forehead draws the corresponding eyebrow upwards (Stimson). The frontal flap, however placed, is now raised from below upwards, so that the necessary hæmorrhage is rendered as little embarrassing as possible, and with no more handling, or pinching with forceps, than is unavoidable. The knife should be kept away from the flap towards the periosteum, and used in the same plane throughout, without any scoring whatever. The hæmorrhage, free at first, is readily arrested by forcip-pressure (leaving on Spencer Wells's forceps for a while) or by sponge-pressure. The flap, being sufficiently raised to hang freely and without tension, is then twisted slightly to one side (that on which the pedicle has been cut longest), and brought down and adjusted to the pared edges below by means of numerous fine sutures of salmon-gut, fine silver wire, and horsehair, all being introduced with very small needles.

If the condition of the forehead has admitted of taking a columella from there an appropriate groove must also have been cut in the upper part of the median line of the lip, and the two carefully adjusted. If no columella can be taken from the forehead, the upper lip must furnish it, either now, if the patient's condition admits of it, or later on, when the pedicle of the frontal flap is divided. If no columella is made now, the flap, when attached, must be supported by gently introducing appropriate sized plugs of iodoform gauze wrung out of lysol lotion. If a columella is made, two bits of drainage-tube or Jacques' catheter are introduced. The parts, being painted with collodion and iodoform, are well covered in with salicylic wool, but in keeping this in position no pressure must be made with bandages on the new nose.

The forehead wound, on which sponge-pressure has been made, is now partially closed with one or two hare-lip pins and sutures, but in introducing these great care must be taken not to constrict the pedicle of the frontal flap. Now, and later on, healing may be here promoted by skin-grafting by Thiersch's method (p. 233).

The chief points in the after-treatment are not to change the dressings too frequently, to use the utmost gentleness in doing so, to remove the sutures gradually, and to be on guard to prevent the onset of infection or of secondary hæmorrhage. The former will be known by a sudden rise of temperature, vomiting or nausea, and is best treated by hot boracic-acid fomentations and by a sharp purge. Hæmorrhage may occur, according to Sir J. E. Erichsen,* as late as the ninth day. It must be met by careful plugging with aseptic gauze dusted with iodoform or wrung out of turpentine.

The flap remains oedematous for some time, but, if not going to slough, it will be found warm and sensitive. If too much swelling persist, careful punctiform scarification should be used.

* *Loc. supra cit.*, p. 611, is mentioned a case of Lord Lister's, in which hæmorrhage took place on the ninth day, the patient losing over a pint of blood.

Separation of the root of the flap.

Three months after the first operation*—*i.e.*, not until the flap has finished shrinking—the pedicle is divided with a narrow straight bistoury and cut somewhat wedge-shaped, with the apex upwards, an appropriate resting-place being fashioned for it in the skin beneath, which, up to this time, has not been touched. A few of the fine sutures already mentioned are then inserted.

If the patient has been feeble, or if the cheeks are very cicatricial, and thus the new blood-supply to the frontal flap be insufficient, some sloughing may take place, but this is rare.

Formation of a new columella.

If this was not made at the time of the first operation, it should be done at the same time that the pedicle is divided. It is rare that a forehead is sufficiently high to obtain an adequate columella, and the additional thickness and vascularity of the lip make it much more desirable to take one from here. Two assistants, with a finger and thumb at each angle of the mouth controlling the coronary arteries, and at the same time making the parts tense, the surgeon, with a straight narrow bistoury, transfixes the root of the lip just to one side of the middle line and cuts straight down through the free border; a similar incision is made on the opposite side of the middle line, and a narrow strip, about a quarter of an inch in width, is thus detached save above. It is well, in a man, to shave off the skin and hair follicles, and the tip being pared, and the remains of the old columella appropriately freshened, the frænum is freely divided, and the new one united to the remains of the old and to the alæ by one or two fine sutures. The cut surfaces of the lip are then brought most accurately into apposition with a silver wire suture opposite to the coronary arteries, and several points of fine salmon-gut and horsehair. A few more are next inserted to further adjust the columna.

5. Italian or Tagliacotian Method.—This has been but very rarely made use of in this country owing† to the irksomeness which the needful position entails, and the need of a complicated special apparatus.

On the other hand, the absence of any additional scars on the forehead and cheeks, and the abundant flap which can always be obtained, are so important that it may be thought worth while to try this method in female patients who have sufficient time and means, who object to the forehead scar, and who will put up with the inconvenience of cramped restraint for two or three weeks.

Sir W. Mac Cormac brought a case before the Clinical Society‡ in which this method had answered well in a girl aged 16. The following account is taken from his paper. Means for keeping the patient's arm in the needful position for the requisite period were thus provided:

"A pair of ordinary stout well-fitting stays were first procured, to which were attached two perineal straps, to prevent displacement upwards. A helmet, partly made of leather, was connected with the stays by a leather band running up the centre of the neck and back. A leather armpiece, strengthened by a steel band, was moulded so as to extend from the wrist to the shoulder, where it was buckled to the stays. The wrist and hand were fastened to the helmet by a gauntlet, while the elbow could be fixed steadily in any required position by straps running from it to the stays, and to the sides of the headpiece, so that there was nowhere any undue strain, the pressure being so evenly distributed that each strap was almost slack. This apparatus was next applied for some days beforehand, so that any point of undue pressure might be remedied. The girl was able to sleep soundly in it, and it gave promise of proving perfectly efficient. Meanwhile I modelled on the deficient nose a gutta-percha substitute, and from this was able to project on a flat surface the extent of the deficiency. The first part of the operation was performed

* The time usually given—*i.e.*, four to six weeks—so as to allow of establishment of the blood supply to the flap, is insufficient.

† In cases where the destruction is very great, where other methods have failed, where the skin available on the face is much scarred or of doubtful soundness, the Tagliacotian method is especially indicated.

‡ *Clin. Soc. Trans.*, vol. x. p. 181. Three figures are given, of the patient before and after the operation, and of the apparatus used.

thus : A flap was marked out on the inner aspect of the left upper arm, more than double the actual size of the estimated deficiency. The left arm was the one chosen to supply the flap, and the right side of the nose the one first operated on, the septum being fashioned at the same time. The flap was left attached to the upper part of the arm by a broad long pedicle, and so arranged that there should be no traction whatever upon it, whilst the raw surface from which it was taken should be accessible for daily dressing. With the flap I dissected up the subcutaneous fat down to the muscular sheath. Immediate retraction both of the flap and of the denuded part of the arm took place to a large extent, so that the raw surface on the latter was almost co-extensive with the whole inner surface of the girl's arm, the flap appearing quite small in comparison. I now made a slightly curved incision, nearly parallel to the free border of the nose on the right side, and about three lines above it, corresponding, in fact, to where the alar furrow should normally exist. This incision was prolonged some little distance into the cheek in the line of the cheek furrow, whilst the remains of the septum were split open in the median line. This nasal flap could now be turned down so as to become horizontal, or rather a little depressed below the horizontal line, to allow for retraction of the ingrafted piece. A triangular gap, the apex pointing towards the cheek, was thus left exposed on the right lateral aspect of the nose, and into this the triangular-shaped piece from the arm was inserted, and accurately attached by suture, the portion to form the septum being sutured in the groove already formed by splitting the septum. In this way there was no paring of edges, nor was a single particle of nose tissue sacrificed, whilst by having so large a line of attachment, being almost surrounded by living tissue, the new flap was much more likely to adhere satisfactorily in the first instance, and from its freer blood-supply less prone perhaps to subsequent contraction." Union took place in great part by first intention, some sup-puration setting in on the eighth day, owing to the indifferent plastic power of the subcutaneous fat. Healing was not complete for nearly three weeks. At this date the operation was completed by detaching the flap from the arm, cutting this so as to give it a triangular shape, and preparing the left side of the nose to receive it in a manner precisely similar to the right side. The perfect vitality of the now completely severed tissue of the arm was made apparent by copious hæmorrhage, and healing was complete in a fortnight. After the first forty-eight hours scarcely any inconvenience was felt from the apparatus, save for a slight excoriation on one shoulder. The result was good, but it was expected that further contraction would much improve the aspect of the nose, the new organ being fully large.

Grafting bone*—*e.g.*, that of the rabbit—so as to restore the bony bridge. This method, made use of by Mr. Watson Cheyne (*Clin. Soc. Trans.*, vol. xxxiii., 1899, p. 218) with great success in a case of partial rhinoplasty, will probably be much used in the future for re-forming the bony framework of the nose, either in place of taking bone and periosteum in the frontal flap, or in cases where this method has failed. It has been described at p. 455.

Causes of Failure after Complete Rhinoplasty :

1. Gangrene and sloughing.
2. Secondary hæmorrhage.
3. Infection of the wound. Erysipelas, etc.
4. Shrinking and consequent shapelessness of the new nose.
5. Destruction of the new nose by recurrence of the old disease.

C. Operations for Partial Restoration of the Nose.—These are very numerous, and have usually been designed for special cases. A few only will be alluded to here.

- i. In cases where the lower third of the nose is left untouched and

* Hardie and others have replaced the bony framework, causing the freshened tip of the left forefinger to heal into the vivified upper angle of the nasal defect. Fifteen weeks later the finger was amputated in the middle of the upper phalanx.

the central portion especially destroyed: Small square flaps are raised from the sides of the nose and cheeks, to which a small flap from the forehead may be added, and united in the middle line.

ii. **Single Lateral Flap.**—This may be taken in many different ways. (a) From the cheek, at the side of and below the nose. This flap may be raised horizontally, the pedicle lying outwards on the cheek. This is merely a modification of Syme's operation. I have found it give excellent results after operations for lupus, rodent ulcer, and epithelioma, where the cheeks are fairly full and rich in fat (Fig. 152, A). (b) From the opposite side (Langenbeck). Here the flaps are taken vertically. The apex of the flap is left attached to the inner angle of the eye, on the same side as the deficiency, while the base comes from

FIG. 152.



Rhinoplasty. Single lateral flap.
(Stimson.)

FIG. 153.



Rhinoplasty. Denonvilliers' method.
(Stimson.)

the ala of the sound side (Fig. 152, B). (c) M. Denonvilliers' method. A border that has already cicatrised is made use of so as to prevent subsequent narrowing. A triangular flap is marked out by incisions shown in Fig. 153, the pedicle being internal. The flap, having been carefully raised with a strip of cartilage in its lower margin, is displaced downwards into position, and retained there by the V-shaped wound being sutured in the shape of an inverted Λ .

In all the above methods, if cartilage is not included in the free border which is to form the new ala, the flaps should be cut long enough to allow of turning this border upon itself and thus giving a thicker and more natural appearance to it, and in all care must be taken that the new ala is patent, and there is no after-displacement of the upper lip or lower eyelid.

(d) M. Weber's Method.—The flap is taken from the upper lip: on account of the hair follicles this plan is best suited to women. An oval flap is taken, usually from the centre of the lip, with its pedicle left attached close to the columella and its free margin reaching to the prolabium. The flap, which consists only of part of the thickness of the lip, is turned up, and stitched to the remains of the ala, which have been refreshed. The wound in the lip is closed or grafted. In three or four weeks this pedicle is divided, and may be so united to the inner surface of the flap as to give it a thicker and rounded margin.

Subcutaneous Injection of Sterilised Paraffin especially as a means of correcting Saddle-nose.—This method was first introduced by Gersuny of Vienna in 1899. As I have no personal experience here, the following details are taken from the writings of Dr. Walker Downie (*Brit. Med. Journ.*, vol. viii. 1902), Mr. Stephen Paget (*ibidem*, Jan. 3, 1903), and Dr. Milligan of Manchester (*Med. Chron.*, 1902, vol. iv. p. 333). Mr. Paget has operated on 26 cases, the results shown in many of the photographs which accompany his and other papers on this subject are admirable.

Sterilised paraffin with a melting-point of 110°F. to 115°F. is used. If the melting-point be only 104°F. it tends to set in the needle, if it be as high as 125°F. to 135°F. it is very difficult to prevent its diffusion, while this degree of heat may do damage to the tissues; finally, too liquid paraffin may escape after the needle is withdrawn. Mr. Paget, having tried many forms of needle, prefers that of Eckstein. The syringe and the proximal half of the needle are jacketed with india-rubber, the syringe is easily worked with one hand, and there is a screw-nut on the piston which prevents the paraffin going in with a jerk, and it cannot inject too much paraffin. The skin is duly sterilised. A general anæsthetic is usually required, especially on the first occasion. The paraffin and syringes—it is best always to have two syringes, in case one gets out of order—are kept in a water-bath 6° or 7° above the melting-point. The skin is nicked for the needle; about 6 c.c. of the paraffin are taken up, and the syringe held in the water-bath while the screw-nut is adjusted; then the needle is dipped for a second or two into boiling water. It should not be passed through the flame of a spirit lamp, for this method stains the paraffin in it. To prevent diffusion into the eyelids and forehead an assistant should make strong pressure with his fingers and thumbs meeting in a ring, especially over the lateral aspects of the nasal bones near the inner canthi. Dr. Milligan has used a thin strip of lead moulded around the area of operation; on this pressure is made. The needle is quickly driven into the subcutaneous tissues, its point being well driven down towards the tip of the nose, from above, or introduced a little to one side of the middle line, below the point where the bridge ought to be and directed upwards. The injection should be made at about the rate of one cm. every ten seconds. It is better to inject too little than too much paraffin, a second or a third injection being made later, if needful. The needle should not be entirely withdrawn until the amount of paraffin required is injected and the moulding carried out. This is carried out by the left hand; the insertion of a little finger in the nostril is sometimes a help. The paraffin begins to set in less than a minute, but remains doughy for about a quarter of an hour. The moulding and squeezing the nose into a good shape must be done pretty vigorously, and must not cease till the paraffin is unimpressionable. The puncture is closed with collodion, and iced boracic acid lotion applied for a few hours. The immediate effect of the injection is to make the surrounding skin pale as well as tense. This pallor soon passes off. Pain is not, as a rule, much complained of. If no anæsthetic is given, there must be no movement when the puncture is made. As to the permanency of the results, Dr. Milligan states that cases, carefully watched a year, have shown no tendency

alter to any appreciable extent. Even if, after some years, absorption should take place, repetition of the injection would always be possible.

Difficulties in effecting much improvement will chiefly arise in the following cases (Paget):—Where the skin is adherent, as after scarring due to syphilis, in cases chiefly congenital. Here the subcutaneous use of a fine tenotome may help. Connell (*Journ. Amer. Med. Assoc.*, Sept. 1903), in the case of very tight tissues, loosens them a few days before with a tenotome; at the time of the injection he uses sterilised saline solution before the paraffin. Where there is very little room between the forehead and the end of the nose, or where this is broad, coarse, or splayed out.

The following are the chief sequelæ which may be more or less disastrous.

1. Unless sufficient pressure is maintained all round the area injected very disfiguring nodules of paraffin may remain in the adjacent loose cellular tissue. The after-removal of them is a matter of the greatest difficulty from their adhesion to the connective tissue.

2. Thrombosis of the facial vein and pulmonary embolism have very rarely followed the injection of paraffin. In the *Lancet* for April 9th, 1904, a case is published in which the injection of paraffin was followed immediately by blindness of the right eye, probably from embolism of the central artery to the retina.

An injection had been made on two previous occasions without any untoward result. A mixture of paraffin and white vaseline at a temperature of 110°F. was injected from below upwards. At the moment of injection the patient stated that he could not see. A slight ecchymosis on the tip of the nose perhaps indicated puncture of a vein. Twenty-five minutes after the injection it was found that the inferior branch of the central artery of the retina was collapsed and empty.

3. Suppuration is extremely rare after the operation for saddle-nose.

That the method of paraffin may be followed after an interval of months or years by very serious suppuration, is shown by Mr. F. C. Wallis (*Lancet*, Jan. 28, 1905, p. 221). Two cases are recorded in which this method had been employed for prolapsus of the uterus and rectum especially. It is pointed out that paraffin, though sterile when introduced, cannot be relied upon to remain so, especially in regions where pyogenic micro-organisms always abound.

Many other instances in which Gersuny's method has been suggested or employed—many of them extravagant—are recorded in the above papers. Amongst the most promising are the filling up of large cavities left after operations on the mastoid bone, elevation of depressed scars, especially about the face, and elevation of the cheek after removal of the upper jaw. Connell (*loc. supra cit.*, fig. 6, p. 580) gives a good illustration of a case where he succeeded in restoring the tip of a nose (which had been bitten off) by the injection of paraffin.

ROUGE'S OPERATION.*

Indications.—Whenever the surgeon desires to gain free access to the nasal cavities, without an external scar, as in cases of—

1. Intractable ozæna.† Thus, when previous persevering treatment, including Thudichum's douche, fails to cure cases of ozæna, with obstinate inspissated crusting of discharge under the turbinated bones; when dead bone is detected by a probe, or is believed to be present.
2. In inveterately recurring nasal polypi, persisting after the steps advised at p. 466.
3. As a means of examining the nasal cavities.
4. For lupus of the nasal mucous membrane.

Operation.—An anæsthetic having been administered, the surgeon must decide as to what steps he will take to prevent the blood from getting down into the pharynx. This may be done either by plugging the posterior nares, or by performing laryngotomy and plugging the fauces with a sponge (pp. 614, 624). If the hæmorrhage is likely to be troublesome, and the operation prolonged, I much prefer the latter precaution, for I have found that when the nostrils are plugged it is quite possible to sever the silk on one side, owing to its being hidden by clots, and its whereabouts thus not seen. Wire is less easily severed. Plugging the fauces after a laryngotomy has the further advantage of leaving the posterior nares free for examination by a finger passed from the mouth, a point of importance in examining these parts, or in manipulations in the case of a polypus.

The upper lip having been well raised and everted by an assistant, who stands behind the head of the patient, taking hold of it at the angles of the mouth, the surgeon frees it from the upper jaw by an incision through the mucous membrane reaching from the bicuspid teeth on one side to their fellows. In doing this the knife should be kept close to the bones and parallel with them. The cartilaginous septum is next detached from the anterior nasal spine, and the lower lateral cartilages from the upper jaw, the adjacent parts of the cheek being also freed at the same time so as to admit of the nose and lips being lifted up sufficiently to explore the nasal cavities.

After any dead bone has been removed, the sharp spoon applied, and the nasal cavities thoroughly cleansed in cases of ozæna, or any polypi or lupus dealt with, formalin is applied, the parts are replaced (without sutures), and a boracic acid fomentation applied until the pain and swelling have subsided, and the risk of infection has gone by. Attention must be paid to keeping the mouth clean.

Other operations on the nose are given later on under the heading of "Naso-pharyngeal Fibroma," p. 495.

REMOVAL OF NASAL POLYPI.

It is to be understood that in the following remarks I am writing for those who have no especial experience in nasal surgery, and

* *Nouvelle Méthode pour le Traitement chirurgical de l'Ozène*, par le Dr. Rouge, Lausanne, 1873.

† Mr. Hayward (*Syst. of Surg.*, vol. ii. p. 644) believes that in a large number of cases of ozæna the discharge is due to a carious surface being present on the base of the skull. If this view is correct, it obviously points to not putting off this operation too late.

who are placed under conditions in which they have to rely upon themselves.

Before an operation is undertaken on nasal polypi it must always be remembered that they fall into two chief groups, (a) those in which they occur alone or with merely a chronic osteitis of the subjacent bones, (b) those in which caries of the bones, and disease of the accessory sinuses co-exist (p. 335). In these latter cases suppuration is always present, and there will be evidence of carious bone to the probe or to the finger, when the patient is under a general anæsthetic; the discomfort, especially headache, will be aggravated.

There is a tendency amongst many specialists in nasal surgery to teach that the obstinacy with which nasal polypi tend to persist is due always to co-existing disease being overlooked. They are not however agreed amongst themselves on this point, and it is denied by many. Thus Prof. Kümmell (v. Bergmann's "System of Practical Surgery," *Amer. Trans.*, vol. i. p. 785), speaking of Greenwald's view that most nasal polypi are caused by "a focus of suppuration," such as an accessory sinus empyema, states, "The author has never seen any traces, in numerous cases which have come under his observation, of a macroscopically accessory sinus or bone disease." In my own experience, cases of nasal polypi without suppuration or bone disease, and with only the usual clear watery discharge, are common, and it is to this class of case only that the following advice applies.

As the well-known tendency of these growths to persist must be due, where no other disease is present, to their occupying sites of difficult access, and the exquisite sensitiveness of the nasal mucous membrane, I strongly advise general anæsthesia. Those with especial experience will obtain radical results by numerous sittings and local anæsthesia only. Where a surgeon without such experience yields to his patient's wishes and dispenses with general anæsthesia, he, in my opinion, courts defeat. In spite of its causing congestion of the parts, I have always used ether to begin with, on account of its greater safety. It should not be pushed so far as to abolish the laryngeal reflex. As it is very difficult to be thorough enough I have retained the advice given below by Sir W. Mitchell Banks. I have been strongly criticised for doing so, and the method has been described as barbarous. Sir William, while alive, was well able to take care of himself and his writings. Now that he is dead I shall not withdraw his teaching, because it emphasises, in the terse and vigorous diction habitual with the writer, the need of thoroughness. It admits, as will be shown, of certain additions and modifications. Thus cold wire snares are preferable to forceps. Whichever snare is preferred, more than one should be at hand according to the size of the wire required. Krause's, Blake's and Lack's are, I consider, the handiest and most useful. Blake's is a very convenient form and is useful for all ordinary delicate polypi and those situated high up. Lack's snare carries two shafts, the stronger of which can be relied upon to remove any tougher polypi or part of the middle turbinate itself. A small and large ring-knife will be found far superior to sharp spoons and should always be at hand. It is well not to use too fine wire as it so soon gets damaged, and moreover it cuts the neck of each polypus through instead of pulling the growth away with its base and, if possible, a little bone in it. The wire-loop is first carefully passed round the lower extremity of

a polypus, and then pressed well home as high up as possible, the wire being gradually tightened as this is done. If forceps are used—I do not recommend them—the points should be kept backwards parallel with the middle turbinated bone and not upwards to the base of the skull, or fatal mischief may easily be inflicted upon the delicate bones situated here. A finger in the posterior nares, the mouth being opened with a gag, is often of the greatest service, especially when polypi are situated far back. Where the middle turbinate is much in the way, where it is covered with sessile polypi or where it is found carious it is quite easy to cut it away in two or three pieces with a Meyer's ring-knife. The hæmorrhage, which is always free, is met during the operation by keeping the patient's head turned sideways and dependent over the edge of a low table. When the operation is completed and the finger introduced from in front as well as behind finds the cavities free, these should be plugged with sterilised gauze wrung out of adrenalin chloride, 1—1000. After this is removed formalin, 1—500 or 250, should be applied with gauze or wool swabs. No operation on nasal polypi should be considered complete without this step. It is not only a powerful disinfectant but it dries up the œdematous mucous membrane in a very remarkable way. Its only objection is the after pain which it causes, and I confess that in all the cases in which I have used it, viz., lupus, nasal polypi, and inoperable sarcoma, I have failed to do more than partially relieve this pain with eucaine and with morphia subcutaneously. Powered orthoform is worth a trial. But the pain is well worth endurance. The application of formalin also does away with the need of using insufflations of aristol and boracic acid, or of antiseptic lotions which are otherwise indicated, and which most patients use inefficiently.

Dr. Bronner of Bradford, whose writings are always practical and instructive, also advises formalin (*Brit. Med. Journ.*, 1903, vol. ii., p. 1135). Having had extensive experience in nasal surgery he operates with eucaine, and before using formalin he applies a powder consisting of cocaine, eucaine, and desiccated suprarenal extract in equal parts. After a few days he orders a formalin spray (1—500 increased up to 1—100) to be used three times a day for a week or two, and then less frequently. Where patients are especially sensitive to formalin he advises a paroleine spray before the formalin.

Patient should be seen at intervals of every four or six weeks. Any slight recurrence is operated on with eucaine, and formalin applied again. In the majority of cases a cure will be effected. Those who, in deference to their patient's wishes or because an anæsthetic is not easily available, dispense with one, should especially give formalin a trial.

Sir W. M. Banks's method is given in his own words* :—

"As to the most permanently curative operation for nasal mucous polypi, I believe there is nothing equal to the use of the forceps properly managed. Where there are large isolated polypi with well-marked stalks, the wire snare or Dr. Thudichum's process may do well enough, and probably removes them with much less pain than the forceps. But these are not the most common cases. On the contrary, they are usually crops of small growths fringing the superior and middle

* *Clinical Notes upon Two Years' Surgical Work in the Liverpool*
p. 180.

bones, which no snare can get hold of, and which in due time make their appearance as large ones. Mr. Syme, after great experience, used to say that the only way was to get one blade of the forceps beneath the middle turbinated bone and the other on the opposite side of it, and to carry away as much bone as possible. This I always endeavour to do, and find that, along with the big ones, I have brought away whole crops of minute polypi just commencing their existence, which can only be removed by carrying away the bone from which they grow. As to necrosis and all sorts of contingencies which it is said *may* occur as a result of such rough surgery, the simple answer is, They don't occur. On the other hand, the patient has a chance of getting rid of the source of his trouble, and does not need to come every two or three years to have a fresh assault made upon a fresh lot. Failure often results from using forceps which are too big in the blades, and which are only toothed in the points instead of all the way down. In not a few cases where the patient has had several operations performed previously by other surgeons, I have simply smashed up the whole turbinated bone as widely as I could, and so have settled the matter permanently. Now the pain and dreadful sensations produced by this proceeding are more than mortals can bear, and so the patients have had chloroform or ether, and it would be an excellent thing if this were resorted to more frequently. Even a moderate assault with the forceps is a most horrid process, and patients who have gone through it once or twice will endure any amount of chronic misery rather than face it again. But only a very few surgeons seem inclined to give these unfortunates an anæsthetic, urging as their reason the danger of blood going down the throat and choking the patient, and the fact that, owing to the patient being insensible, he cannot blow down the nostrils so as to let it be known whether they are clear or not. My plan is to have the patient thoroughly anæsthetised on a sofa. When fully insensible his head should be brought over the edge so that the nostrils are dependent, and then the surgeon, kneeling on the floor, passes up the forceps, and pulls out everything he can until there is nothing to pull. Meantime, all the blood runs out of the nostrils, and none need go down the throat at all, while the whole time necessary for a thorough cleaning is about a minute for each nostril. I feel convinced that, for certain cases, the only satisfactory cure is to pull away as much as can be got of the superior and middle turbinated bones."

REMOVAL OF ADENOID GROWTHS OF THE NASOPHARYNX AND ENLARGED TONSILS.

Here as in the previous section and indeed throughout this book, I desire that it be remembered that I am writing only for the benefit of my junior brethren, and in view of the conditions under which they are, of necessity, often placed. A surgeon who has had especial opportunities afforded him of acquiring great skill is justified in saying that an anæsthetic is not needed, that it increases hæmorrhage, and that only one movement of the curette is required. The following remarks apply only to men placed under very different conditions.

Question of Operation.—The fact that removal of adenoids has been much abused, that it is a good instance of "intemperance in operating"

or "the lust of operation" was shown in a recent discussion in one of the medical papers, and needs no further allusion here. The need of operation will mainly depend on (1) the extent to which the vitality of the patients are affected and (2) their surroundings. Where it is quite clear that the adenoids themselves* have seriously interfered with the nutrition and vitality of the patients and have rendered them liable to naso-pharyngeal catarrh, bronchitis, deafness, etc., operation is strongly indicated. In slighter cases, where the surroundings are satisfactory and where attention will be duly paid to carrying out palliative treatment, atrophy may be expected to follow. Nose-breathing, even if systematically carried out, will have no curative effect on established adenoids, any more than it will upon enlarged tonsils. A word of caution is needed here. Where the adenoids are causing enlarged glands, operation is indicated, but the surgeon should prepare the friends for the possibility of suppuration in the glands after the operation, especially where the vitality is poor, the surroundings unsatisfactory, the glands already tuberculous, or where another member of the family suffers from a like condition of the glands.

Removal.—Here the first points that arise are the best *anæsthetic* and the most suitable *position of the patient*. Both points have been much debated.

Anæsthetic.—I have no hesitation in expressing my preference for ether, preceded when possible by gas, in the majority of cases, *i.e.*, those of average severity, and I consider ether especially preferable when the anæsthetist can be only of ordinary experience and skill. I am well aware of the objections which have been raised to ether here. In addition to the administration being more troublesome, the parts operated on are more vascular and swollen, the hæmorrhage is somewhat greater, and more mucus is present than is the case with chloroform. But I am equally assured that the advantages of ether outweigh the above disadvantages. Above all, it is safer than chloroform in hands of ordinary experience. Where, in young and often feeble patients, elements of shock must be present—*e.g.*, hæmorrhage and interference with the respiratory passages—chloroform is always risky, and, unless given with much experience, may be most dangerous.† Ether enables

* I will call my readers' attention here to the fact that several morbid conditions may simulate adenoids. In two of my cases operation gave incomplete relief, because I had overlooked the co-existence of hypertrophy of the posterior ends of the two lower turbinate bones, causing blocking of the posterior nares in the one case, and marked ill development of the naso-pharynx and its muscles and those of the soft palate in the other. Such conditions will obviously interfere with after-treatment by nasal breathing, however faithfully carried out. Dr. W. Wingrove (*Brit. Med. Journ.*, 1901, vol. ii. p. 892) enumerates the following as simulating adenoids and as not recognisable by anterior rhinoscopy :—(1) Diminutive posterior and anterior nares ; (2) Low pharyngeal vault ; (3) Paresis of soft palate and pharyngeal muscles ; (4) Prominent crest of the vomer ; (5) Forward projection of the upper three cervical vertebrae, especially the atlas ; (6) Retro-pharyngeal abscess ; (7) Undue prominence of the tuberosities of the palate and the hamular processes ; (8) Webs and new growths.

† That sound and careful surgeon, Mr. Waterhouse (*Clin. Journ.*, 1896, p. 281), while preferring chloroform to ether, writes of chloroform as follows :—"There have, however, been, even in many deaths, no the removal of adenoids out a certain

any change in the patient's position to be safely made, and, if obstruction to respiration should take place, there is less risk of cardiac failure. With chloroform, cardiac failure may ensue at any time from the shock, from the hæmorrhage, from obstruction to respiration; from any needful sudden change in the patient's position; and, lastly, it may occur without any warning when the operation is over, and the effects of the anæsthetic seem to be safely passing off. In a *severer* case, or where the tonsils also are going to be removed, as soon as the patient is well under the influence of ether, chloroform may be substituted with advantage. It is only in *slight* cases that gas and oxygen will suffice. With this limited anæsthesia there must be a tendency to hurry, and thus a risk of an imperfect operation. I strongly advise operators whose experience is limited to avail themselves of the longer anæsthesia of ether, however slight the case may seem to be. Whatever anæsthetic is chosen, it should be pushed with care. Thus, while the corneal reflex should be abolished, that which governs coughing and swallowing should not be entirely removed.

Position.—This again has been much debated. I shall refer to a choice of three positions. I much prefer the first.

1. The patient lies on the right side, with the head somewhat raised, and bent a little forwards over the edge of a table of appropriate height. If blood accumulate at the back of the throat, if there be the least tendency to lividity, the child should be rolled over and the blood sponged out. The anæsthesia is never to be deep enough to abolish the laryngeal reflex.

2. The patient, under ether, is propped up in the sitting position, with the head and shoulders thrown well forwards, and the face looking downwards into a basin placed between the patient's knees. This position is only justifiable with ether. It is an excellent one from the anæsthetist's point of view, owing to the facility and safety with which blood escapes from the mouth. It is not quite so convenient to the operator. We owe it to Mr. Braine.

3. The patient lies on his back, with the shoulders a little raised, and the head thrown back and hanging over the end of the table. In this position the head is supported by an assistant or nurse. This is the same position as that used in cleft palate operations. "It answers admirably for both operations, as the blood thus falls down into the pharyngeal dome, and wells up through the anterior nares,* leaving the lower air-way free and open. . . . I do not think that this lowered position of the head adds materially to the amount of bleeding" (Owen's *Surgical Diseases of Children*, third ed., p. 208).

Operation.—We will suppose the patient to be in the first of the above given positions. One of Hewitt's modified Mason's gags is inserted†

element of risk. I have used it hundreds of times, but always with fear and trembling, which, by the way, is not an unwise precaution when dealing with this powerful and dangerous drug."

* But if, as often happens in these ill-developed patients, "nasal obstruction is present even in a minor degree, this position is not a good one for the escape of blood" (Hewitt, *Anæsthetics and their Administration*, p. 37).

† Care must be taken now with any loose or decayed teeth. The insertion of one of Hewitt's props, whenever the little patient will permit it, before the mouth-piece is applied, will facilitate the introduction of a gag at the height of anæsthesia.

and securely held, as widely opened as possible, on the left side. The operator now examines into the extent to which the adenoids have developed and into the possible co-existence of other morbid conditions (*vide supra*). An assistant should be ready with clean sponges, as large as are admissible, firmly fixed on holders or forceps, to sponge out blood rapidly and efficiently from the right cheek and side of the mouth. The removal of the adenoids may be effected with the nail, the artificial nail, a curette, or forceps. (1) *The Natural Nail*.—The advantages of this are obvious; it is simple, it takes up a minimum of room, and its natural sensitiveness is a great aid to the operator in detecting the position and extent of the growths. The objections are its insufficiency, thus leading to the need of repeated operations. This may be due to want of care. The finger-nail must be long enough, but not too long or brittle so as to bend or break. It must only be used for slight cases and where the adenoids are soft; in the much rarer ones, firmer and harder, met with sometimes in older patients, the curette should be used. In most cases the use of the finger-nail should be kept to complete the operation after the employment of the

FIG. 154.



Golding Bird's curette. (Down Bros,' Cat.)

curette. If it be used it must be with proper precautions, and employed thoroughly. In a naso-pharynx blocked up with adenoids, the finger introduced behind the soft palate should first make out the septum and outline of the posterior nares, and clear these thoroughly; next, pressed upwards into the vault of the naso-pharynx, it is drawn firmly backwards and downwards several times, first in the middle line and then laterally, care being taken as the orifices of the Eustachian tubes are approached. The adenoids thus removed are partly expelled with the blood through the nose, partly mopped up, and some swallowed. (2) *The Artificial Nail*.—This has only slight advantages over the ordinary nail: it does not break or bend, and it penetrates more deeply. Its disadvantages are great, viz., the impairment of tactile sensibility and the increase of bulk which it entails; the latter a point of importance in a little child. (3) *Curettes*.—The best of these are some modification of Gottstein's (*e.g.*, Golding Bird's, Fig. 154, Beckmann's, or Kirstein's, Fig. 155); Mr. Steward advises the last, as the large fenestra enables the mass of Luschka's tonsil to be brought away in one piece (*vide infra*). Mr. Golding Bird's instrument, in my opinion, reaches better than any other curette those adenoids situated high up at the junction of the roof and back of the naso-pharynx. The fenestra of the curette, having been guided into the naso-pharynx by a forefinger, is passed upwards and backwards quite up into the vault; then, the position of the cutting edge being determined and the handle being held firmly, the curette is pressed well down upon the roof of the pharynx, and drawn backwards and downwards and laterally, with

semicircular turns of the wrist, so that its sharp edge is made to sever all the vegetations in its sweep. Sufficient pressure must be used to go through mucous membrane structures only, and not into the muscular edges. No strips or tags of incompletely removed tissue should be left hanging down. This is repeated according to the severity of the case and the results found by the finger, but the lateral aspects of the naso-pharynx, especially the vicinity of the Eustachian tubes, should be carefully avoided by the curette. Here, as in the regions curetted, the finger-nail should complete the work. In buying a curette the surgeon should remember that instrument-makers often turn out these (and Lowenberg's forceps also) monstrously large for the naso-pharynx of a little child. The following is the method which Mr. Steward advises and which those who have had his opportunities for attaining special skill may adopt (*Clin. Journ.*, April, 1905). "The operator stands behind the patient's head. The instrument (Kirstein's modification of Gottstein's curette) should be held like a dinner-knife, with the index finger along the back, this gives the best control. Having passed the curette into the naso-pharynx the handle is depressed till the edge touches the back of the septum. Pushing then firmly upwards and backwards the mass to be removed is then pressed into the fenestrum, with the cutting edge at the upper margin. Unless the instrument is pressed up as well as backwards the upper part of the mass will not be caught, and removal will then be incomplete. The handle is then raised, pressing backwards all the time, the cutting edge thus making a firm sweep along the upper and posterior walls of the naso-pharynx. In this way the whole mass is cut off cleanly and comes down into the mouth with the instrument. Luschka's tonsil is the cause of the trouble, any smaller masses which may be present round the posterior nares or about the Eustachian tubes need no interference if the main mass be removed and nose-breathing properly practised afterwards." From my experience, in addition to the median mass, large and multiple fringes are often present especially about the posterior nares, and it is always well to feel with the finger that these orifices are absolutely clear, by identifying their boundaries. (4) *Lowenberg's Forceps*.—These are only required when the adenoids are firm and fibrous and tough, being quite unnecessary in the soft vascular adenoids usually met with in early life. It sounds easy enough to introduce the forceps, guided by the finger, into the naso-pharynx, push them up to the roof, and then to press them into the adenoid masses, out of which, by a combined punching out, twisting, and tearing, the growths are pulled away, or, in cases of really firm adenoids, pieces punched out until the rest can be removed by the curette or finger-nail. But practically it will not be found easy, in the naso-pharynx of a child, to simultaneously accommodate both finger and forceps, and to manipulate the forceps with the necessary freedom. And unless the blades are accurately guided by the finger it is easy to seize and bruise the septum (especially when the head is in the dependent position) and to tear away strips of mucous membrane. Very grave, even fatal, hæmorrhage has also followed the use of the forceps. The forceps usually sold by instrument-makers are absurdly large for children, in whom a great proportion of post-nasal growths occur. The best forms are those of Symonds and St. Clair Thomson's modification of the

Jurasz-Lowenberg's forceps (*Brit. Med. Journ.*, vol. i. 1898, p. 632). These forceps are particularly light and short, making it easier to use the finger at the same time. With these and all modifications of Lowenberg's forceps opening laterally, care must be taken not to damage the orifices of the Eustachian tubes.

After-treatment.—The patient should be kept on one side for some time after the operation, and carefully watched, especially on account of the vomiting of blood, which is almost certain to follow. The hæmorrhage, severe at the time, soon ceases, and very rarely causes anxiety a few hours later. In such cases, iced boracic acid to the face, syringing hot water through the anterior nares, the patient being in the position I have already advocated, or the use of adrenalin chloride, 1—1000, must be tried. The child, if delicate, should be kept in bed for two or three days, and in damp or wet weather should not leave the house for a week. For the first twenty-four hours the food should be cold. As a rule, especially in little children, where the parts are so small and delicate, any use of the syringe or Politzer's bag is to be deferred until sufficient time has elapsed to show the result of the operation. Warm boracic acid may be used if the discharge show signs of becoming muco-purulent. The friends should be prepared for the breathing being even worse than usual for the first two or three days. Improvement, especially in the gain in nose-breathing, begins from the fourth to the seventh day. The atrophy of any remaining adenoids will be promoted by the practice of nose-breathing, the child being made to sit quiet for ten minutes four times a day, and breathe through the nose alone. All possible pains must be taken to improve the general health.

Complications and Sequelæ.—1 and 2. Hæmorrhage and Shock.—I have already spoken of these, and would here again remind my readers that, in addition to deaths under chloroform, there have been fatal results from hæmorrhage. While this complication, not owning any arterial source, usually quickly ceases of itself, and, when severer, yields to plugging of the naso-pharynx with gauze wrung out of turpentine or adrenalin chloride, if these be available, fatal cases have undoubtedly occurred both at the time and a few hours later. In a few this result may have been due to hæmophilia; in others, from the accidental tearing off of pharyngeal mucous membrane, or direct injury to a large blood-vessel (Newcomb), both these accidents being more likely to occur with Lowenberg's forceps. Dr. Newcomb candidly published (*Amer. Journ. Med. Sci.*, 1893, vol. cvi. p. 574) a case in which death took place from hæmorrhage sixteen hours after the operation. While, as medical aid was not summoned until this time had elapsed, no blame whatever can attach to the operator, the case shows the importance of keeping these patients under observation for twenty-four hours.* 3. Broncho-pneumonia from the entrance of blood into

* Dr. Newcomb refers to a case, reported by Hooper, where a digital examination in a hæmophilic subject caused a fatal hæmorrhage. He also alludes to two other fatal cases, recorded by Dr. Delavan (*Trans. Amer. Laryngol. Assoc.*, 1892, and *New York Med. Journ.*, Nov. 19, 1892). He warns against operating on patients approaching the time of menstruation, and those in whom there has been any recent inflammation of the throat. Dr. Preble has recorded a case in which secondary hæmorrhage occurred on the seventh

the lungs. 4. Infection of the wounded surface. 5. Ear trouble.—In a few cases pain in the ears is complained of, probably due to entrance of blood into the tympanum along the Eustachian tube. Another rare and more serious aural complication is otitis media from injury to the Eustachian tube, infection of the wound, or unwise use of the nasal douche. If deafness was present before the operation and has not improved ten days after, Politzer's process with the application of astringents to the naso-pharynx will be indicated. 6. It is not very uncommon for some of the cervical glands to become painful and swollen, but, unless the wound has been infected, especially if the patient's vitality is very low, suppuration does not follow. 7. Exanthemata.—Mr. Sheild (*Diseases of the Ear*, p. 213) calls attention to the importance of the operation wound not being exposed to the virus of scarlet fever, diphtheria, or sewer-gas. 8. Question of Reappearance.—This is stated by some to be common. I have found it distinctly rare myself, when the operation has been properly performed, though parents are liable to take several conditions which may co-exist with adenoids for the reappearance of the adenoids themselves. Reappearance or, more correctly, persistence of adenoids is not uncommon when the operation has been done "against time," either for show, or because the operator has been nervous about the anæsthetic. Where the

FIG. 155.



Kirstein's curette.

finger-nail has been solely employed, especially in cases which call for the curette—*e.g.*, the more fibrous, tough processes, either tongue-like, or sessile and ridged, which are met with in older patients,—in such persistence will follow. If the adenoids have been properly dealt with, and mouth-breathing persists, some other cause must be sought for. Very likely nose-breathing has not been assiduously practised; or some such condition as enlarged tonsils, deviation of the septum, enlargement of the posterior extremities of the turbinals, hypertrophic rhinitis, or the rarer conditions mentioned at p. 469, may be present and require attention. All such conditions should have been detected at the time of the first anæsthetic, and, if not dealt with then, the patient's friends should have been made aware that more would require to be done.

REMOVAL OF ENLARGED TONSILS.

This is so minor and usually uncomplicated an operation that I only allude to it here to urge my readers to give a trial to enucleation.

day, the patient, æt. 11, fainting. It recurred, and was stopped by plugging the posterior nares. On the eighth day a sudden gush took place, and the patient died before assistance could be given. There was no history of hæmophilia. Dr. Preble has collected twenty-one cases of serious primary hæmorrhage, of which four proved fatal, and five of secondary hæmorrhage.

It removes the entire tonsil and is adapted to all cases. The guillotine is easy and rapid, but it will not remove the deep part of the gland, a tonsil which does not project inwards, or one which burrows vertically upwards. If, as is not infrequent, when the slice removed on examination shows cut follicles on its deep surface, there is never any certainty that there will be sufficient contraction to obliterate these and to prevent any further trouble. The objections to enucleation, raised by some, are that it is needlessly severe because recurrence after the use of the guillotine is very rare, and because we may be removing a useful organ; further, a general anæsthetic is required. I admit some force in these objections, but I have reason to doubt the infrequency of recurrence after the guillotine if cases are watched for twelve months; a tonsil which has been the cause of frequent trouble is no longer a healthy organ, and as adenoids are often present as well, general anæsthesia will be an advantage. The patient should be in the position advised for the removal of adenoids, ether or gas and ether are administered, and the mouth is opened in a good light with an efficient gag. With a pair of blunt-pointed curved scissors, an incision is made into the cellular tissue round the tonsil which forms its bed, beginning between it and the anterior pillar. The tonsil is then grasped with a tongue-forceps of the old pattern which will hold, and quickly enucleated with a sterilised finger. The operation is a little difficult at first in the small mouths of children. Hæmorrhage is often free for a few minutes, but is readily arrested by firm pressure with gauze pads wrung out of sterilised adrenalin chloride solution. If this should not suffice, as is occasionally possible in adults, one or two sutures of sterilised catgut should be passed by means of a curved needle held in Spencer Wells' forceps, so as to take up the adjacent pillars and bleeding point, care being taken, of course, not to dip the needle too deeply. This step should remove all the anxiety as to danger of hæmorrhage in these cases, and obviate resort to such steps as ligature of the external carotid.

CHAPTER VII.

OPERATIONS ON THE JAWS.

OPERATIONS OF THE UPPER JAW.

THESE will include—

- i. Removal, partial or complete, for growths (Figs. 156, 157).
- ii. Operations for naso-pharyngeal fibroma (Figs. 158 to 162).
- iii. Opening the antrum.

REMOVAL OF THE UPPER JAW, PARTIAL OR COMPLETE.

Indications.—These include the different growths to which the upper jaw is liable, and opportunity will be taken here to give briefly the chief practical points in connection with these.

i. **Epulis.**—One of the new growths most frequently met with here. Etymologically gum tumours, these growths vary a good deal. At first, and most frequently, they are simply fibrous, tough and firm, springing from the periosteum, the periodontal membrane, and the endosteal lining of an alveolus. Myeloid cells and small spicules of bone are not uncommon. The longer they are left, the more they are irritated, especially with imperfect attempts at removal, the more cellular and sarcomatous do they become.

Very rarely on drawing the tooth, to the alveolus of which the growth is connected, the epulis comes away completely. Much more frequently it is firmly connected to the periosteum and subjacent cancellous tissue, or to the endosteal lining of one or more alveoli. Removal should be early and complete. Shaving off the growth and the gum beneath, and then applying caustics to any suspicious granulations, is most uncertain and unsatisfactory, especially if the presence of teeth be allowed to interfere with the complete removal of the growth, or if this be connected with stumps, and thus dip deeply into an alveolus. By far the best treatment is to draw a tooth in front and another behind the growth, and then with a narrow saw to notch the bone at these points deeply through the alveoli: with cutting-forceps, or better, a chisel and mallet, a V-shaped or rectangular piece of the bone is then removed. In the case of the mandible, this bone must be steadied. The drawing of teeth not only enables the surgeon thoroughly to eradicate the growth, but their removal leads, as pointed out by Mr. Salter,* to wasting of the alveolus, and thus to

* *System of Surgery*, vol. ii. p. 456. Mr. Salter also points out that where an epulis forms on an apparently edentulous part of the jaw, the existence of stumps should always be looked for.

non-recurrence of the growth. The teeth, if sound, and if the patient so desire, should be preserved, and, later on, when all is firmly healed, fitted to a plate by a dentist. The deformity is thus rendered imperceptible.

In 1884, a captain in the Royal Navy, whose ship was on the North American station, came under my care with an epulis of the lower incisors and contiguous alveolar margin. The teeth were all preserved, and, when the parts were soundly healed, Mr. Moon refitted them so skilfully that no trace whatever of an operation could be noticed, and the use of a speaking-trumpet, which was most essential in this case, was not interfered with.

If a patient refuses the only operation which is safe, the surgeon must rest satisfied with shaving off the growth, gouging the subjacent bone, and, if needful, applying caustics to any suspicious patches later on. This course is not only much more tedious and painful, but is uncertain to boot.

2. Fibroma.—These originate either in the periosteum or in the endosteum of the antrum, the connective tissue of the medulla, Haversian canals, vessels, etc. At first firm, dense, and slow-growing, they may, from the frequent irritation inseparable from their site, become vascular, sloughy, and, taking on more rapid growth, tend to invade the numerous fossæ, fissures, and foramina in the neighbourhood of the bone. They should be attacked early; and while the surgeon may need at this stage to remove only the periosteum and bone from which the tumour springs, especially if it be alveolar in origin, or after opening the antrum to shell out the fibroma completely, he must also be prepared for more radical measures, *e.g.*, when the growth is of long standing, of late more rapid, if the patient is at all advanced in years, and especially if the growth is reappearing one.

3. Sarcoma.—These include the spindle, round and myeloid varieties, the fibro-, chondro-, and osteo-sarcomata, and the rarer form of alveolar sarcoma. While the more slowly growing ones simulate more innocent growths such as epulis, the more rapid ones will tax the surgeon's judgment as to whether any operation is justifiable, and all his skill if removal be attempted. On these subjects the reader is referred to p. 480.

4. Carcinomata.—At the present time the softer growths which attack the jaw, and were formerly called medullary cancers, are looked upon as rapidly growing sarcomata. The only true carcinomata met with here are epitheliomata. These are usually of the squamous kind, and commence in the alveolar border in ulceration, beginning in syphilis or the irritation of an ill-fitting tooth-plate. They tend to creep far back, and to invade the palate and tonsil; on this account they should be operated on early. Whenever a sore in this position is suspicious in its characters, and obstinate to treatment, whatever be the age of the patient, the parts affected should be widely and freely extirpated. If the growth has eaten into the antrum or has travelled back so as to invade the pterygoid region, removal of the whole bone is most likely to benefit the patient. More rarely a squamous epithelioma attacks the jaw from the lip or face. This happens much more often in the case of the lower jaw. Another epithelioma met with here is the

tubular* variety (cylindrical or adenoid carcinoma), which begins in the mucous membrane of the antrum or nose. It is marked by rapidity of growth and invasion of the surrounding parts, and is thus of grave prognosis. According to Prof. Schlatter (v. Bergmann's *Syst. Prac. Surg.*, *supra cit.*), carcinomata as compared with sarcomata possess the following characteristics: They usually occur in older patients—the average age in the case of sarcoma is about 35, in that of carcinoma about 55—they are commoner in the upper than the lower jaw, pain is greater at an early date, growth and infiltration are more marked. Involvement of the lymphatic glands is more common in carcinoma, especially in the case of the mandible. In that of the maxilla it is less common, but it is to be remembered that it is the deep glands along the internal maxillary and internal carotid which are affected.

5. Odontomes and Dental Cysts.—Under this heading the commoner odontomes and dental cysts will be alluded to. Of odontomes or growths "composed of dental tissues in varying proportion and in different degrees of development, arising from teeth germs, or teeth still in the process of growth" (Bland Sutton), the commonest are the epithelial and the follicular odontomes.†

(a) The epithelial odontomes (multilocular, cystic epithelial growths of Eve) while occurring as a rule in the mandible have been observed in the maxilla. They are most frequent about the twentieth year. The structure is that of a fairly firm capsule, containing a collection of various sized cysts separated by their septa and containing brownish mucoid fluid. Microscopically they consist of branching columns of cells, often columnar, often imperfect, the origin of which is as yet uncertain. In some cases it may be from remains of the enamel organ, in others from the gum, and in some it is of endothelial origin. While in many cases owing to the bony capsule and the early degeneration of the epithelium these growths have little tendency to spread, where they are of endothelial origin, or where sarcomatous change has set in from irritation, the outlook is much more grave.

(b) Follicular Odontomes or Dentigerous Cysts.—These are formed by a collection of viscid or serous fluid taking place during the development of a tooth, nearly always a permanent one and especially a molar, which has not come through the bone.‡

There are two varieties of these cysts; one, the commonest, is cystic only, consisting of an outer bony shell of varying thickness, and an inner membranous one. The tooth may be well formed or a small,

* Mr. Heath (*Dict. of Surg.*, vol. i. p. 857) quotes Réclus as calling this form *épithélioma térébrant*, from its boring or burrowing tendency.

† For further information on odontomes, especially the rarer forms, Mr. Bland Sutton's *Tumours Innocent and Malignant*, p. 47, should be referred to, with its excellent illustrations.

‡ Mr. Salter (*Syst. of Surg.*, vol. ii. p. 469) gives the following three circumstances as capable of producing impaction of a tooth:—(1) The tooth may be originally developed too deep in the body of the jaw—thus, though it grow in the right direction, it will never reach the alveolar margin; (2) while it may be sufficiently superficial, it takes an oblique direction of growth, so that it lies covered more or less in the axis of the bone; (3) the position of the tooth and its line of growth may be originally normal, but from arrest of the development of the fang it may fail to reach the alveolar edge.

shapeless, calcified mass; its crown usually projects into the sac, vertically or horizontally.

The following points are of practical importance. These cystic swellings may be taken for solid growths, but this mistake may be avoided by remembering that when such a swelling exists there is usually a history of its having commenced in early life, and that though all the teeth may appear to be present, one will very likely be found to be a temporary one. Furthermore, there is the help derived from puncture with a fine trocar,* or a straight bistoury.

In the other variety, usually of longer duration and in older patients, solid growth of a sarcomatous nature is present in addition to the cystic.

6. Dental Cysts.—These usually occur in connection with carious teeth or the stumps of teeth. They are met with in either jaw. Suppuration and a sinus, very rare in the case of follicular odontomes, are more common here. Occasionally they are allowed to grow until clinically they resemble new growths. Their painless slow growth and above given origin should always cause their presence to be suspected.

Treatment.—In the case of the epithelial odontomes where the growth has been slow and the cystic element is the chief one, the operation performed within the mouth should be on the lines of that given for epulis (p. 476), aided by the gouge and small, really sharp curettes. All diseased tissue, cystic or bony, must be removed. The basilar border can always be left. Where the growth is of longer duration, the patient older, and the amount of solid tissue present greater, the whole thickness of the jaw must be resected; and where it is a case of reappearance of a growth, the whole bone should be removed.

In the case of the follicular odontome or dentigerous cyst, the treatment consists in exposing the surface of the cyst by turning the lip up or by making incisions through this as small as possible, then in cutting away freely (with gouge and chisel aided by a $\frac{3}{4}$ -inch trephine if needful) the walls of the cyst, so as to examine its contents, and then digging out the tooth—often the most difficult part of the operation. The cavity is then carefully stuffed with strips of aseptic gauze to encourage its granulating from the bottom. If any swelling persist, keeping up deformity, pressure must be trusted to, the Hainsby's truss of old days being here found useful.

In the other variety of dentigerous cysts, where solid growth of a sarcomatous nature is present in addition to the cystic, the surgeon must use his discretion as to opening the cyst, freely scraping out the growth and then applying strong formalin solution or zinc-chloride paste (p. 434), or removing the bone itself. If the case is of any duration, if the growth is soft and making rapid progress, the latter course will be the wiser one.

In the case of the dental cyst, treatment is usually simple. It consists in the removal of any teeth or fangs, and then in the thorough

* Mr. Fearn, of Derby, was candid enough to publish a case of this mistake in diagnosis in the case of the lower jaw, *Brit. Med. Journ.*, Aug. 27, 1864. The specimen is figured in Mr. Heath's *Injuries and Diseases of the Jaws*, p. 162, and shows well how such a mistake might have arisen. Nowadays the X-rays may be of help.

curretting of the cyst walls. Whenever it is needful, to do this thoroughly, the anterior aspect of the bone must be removed with gouge and chisel to give free access. The cavity when thoroughly exposed and dealt with, is carefully plugged with sterilised gauze wrung out of iodoform emulsion.

7. Enchondromata.—These are rare. They seem to commence in adolescence, usually starting from one surface of the bone—*e.g.*, the nasal, or from the antrum. They should be removed early and completely, as they grow steadily, involving the nose, orbit, frontal sinuses, and thinning the cranial bones.*

8. Osteomata.—These are rare also. Two forms occur: (1) of the nature of an ordinary exostosis. These are usually cancellous, but ivory ones arise from the superior maxilla as well as from the orbit and frontal sinuses. Occasionally they are symmetrical.† Their growth is usually slow. If they occur in young subjects they should be attacked while small. The ivory exostoses are occasionally found loose on laying open the antrum, as is the case with those in the frontal sinuses. (2) Diffuse osteomata. These are intermediate in hardness between cancellous and ivory exostoses. They have often broad, ill-defined bases, and are not infrequently multiple and symmetrical. As they tend to produce hideous deformity, and though slowly, most distressingly, to destroy life, they should be attacked while small. Mr. Pollock (*Syst. of Surg.*, vol. ii. p. 535) quotes Mr. Stanley (*Diseases of Bones*, p. 5) for the statement that in cases where the whole mass is beyond removal, a portion may be cut away with present, if not permanent, benefit. This can only apply to osteomata of purely hypertrophic nature. Where the bony growth is tipped with cartilage every atom must be removed for the operation to be of any benefit. Well-made osteotomes and drills worked by a dentist's instrument may be of much service here, the great object being to drill a number of holes in different directions through the growth, and then to cut through the intervening bone with osteotomes and a mallet. One of the chief risks is that of intracranial inflammation, especially if the growth has involved the interior of the skull.

Questions arising before attempting the Removal of the Upper Jaw.

(i.) Is the growth cystic or solid? (ii.) What is the relation of the growth to the jaw? Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw? (iii.) Is the growth one, whether malignant or not, that it is wise to attempt to remove?

(i.) **Is the Growth Cystic or Solid?**—Mr. Fearn's case, already quoted at p. 479, shows that mistakes may arise here. Mr. Heath gave a case under his own care in which caseous pus, after supuration in the antrum, was taken for a solid growth, and the jaw removed. As the diagnosis is evidently most difficult in some cases,

* Good instances of what these enchondromata may be Morgan's case, *Guy's Hosp. Reps.*, 1842; Mr. Heath's *Dis.* p. 237, with an excellent illustration, Fig. 107.

† In Mr. Hutchinson's *Clinical Surgery*, admirable illustrations of symmetrical exostoses

the surgeon should, in all cases of doubt, explore first with a trocar and cannula, or gouge or bradawl. The X rays may be of assistance here.

(ii.) **What is the Relation of the Growth to the Jaw?**—Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw?

In some cases it is quite impossible to be sure on this point up to the time when the flaps are reflected or till the jaw itself is removed; even the use of a finger aided by an anæsthetic is insufficient.

The following points may be useful in aiding a decision as to the relation of the growth to the jaw:—

If the growth began on the surface of the jaw—*e.g.*, the nasal or malar process—there will probably be a history of a lump noticed here first, very likely after a blow, and any evidence of the antrum, nose, palate, and orbit being involved will be deferred till late. On lifting up the cheek, masses of growth will very probably be found creeping down between the cheek and gums, but not altering the line or affecting the structure of the alveolus, unless it commenced in it or just above it.

If the growth began in the antrum, the cheek is more slowly swollen, and the swelling is deeper and less defined. The different walls and boundaries of the cavities—*viz.*, the orbital, nasal, facial, and zygomatic—are expanded steadily and with a varying rapidity, while the palate is depressed, the alveolar border displaced, and the teeth rendered irregular.

If the growth began behind the antrum—*e.g.*, in the basilar process of the sphenoid or the speno- or pterygo-maxillary fossa—in many cases a history will be given of polypi removed from the nose or pharynx some time before, perhaps reappearing soon; the upper jaw is pushed forwards, and in some cases there is but little alteration in its outward shape, but this is by no means constant. Not unfrequently the upper jaw will be so altered by pressure, its processes—*e.g.*, the malar—so thinned, flattened, and expanded, that it may well be thought that the disease began in the bone itself. And this mistake is the more excusable when it is remembered how easily a growth situated behind the antrum may make its way into this cavity, either by absorbing its walls, or by entering it through the opening into the nose.

Other possible evidence of the existence of a retro-maxillary growth, whether arising in the roof of the naso-pharynx or the above mentioned fossæ will be symptoms pointing to the nose—*viz.*, early discomfort and perhaps increased secretion here, pain here, or in the orbit and brow; epiphora from blocking of the nasal duct; interference with nasal breathing, epistaxis; possibly symptoms of interference with the function and movements of the eyeball; swelling in the temporal region; yet it must be remembered that many of these symptoms will be brought about by a growth within the antrum increasing rapidly.

k, when the surgeon finds no evidence of the growth of its originating on the surface of the bone, no ate, and no irregularity of the alveolar margin or th, that he can say that the growth is probably

(iii.) Is the Growth one, whether Malignant or not, that it is wise to attempt to Remove?—While every case must be decided upon separately, and while it would be most misleading to lay down hard-and-fast rules, the following are not unworthy of attention:—

Favourable Cases.—Growths with a duration extending over many months, hard, well defined, limited to the jaw, with the skin over the growth perhaps thinned from pressure and altered in colour, but still movable over the parts beneath.

Unfavourable Cases.—History of a few months' duration: growth soft, vascular, ill defined; integuments involved and fixed; nasopharynx invaded; extension into orbit or temple—*e.g.*, a soft, semi-elastic swelling noticed behind the malar bone in the temporal region; extension to the sub-maxillary and cervical glands; origin of the growth behind the jaw, rather than on it.

Occasionally, a growth, unfavourable at first sight from its large size, will be found to have protruded on to the face without involving the parts around, and especially those behind.

The history must be carefully examined into. If it be doubtful where the growth began, whether it has invaded or only crept towards the nostril, the surgeon will inquire as to the existence of deep-seated pain, stuffiness in the back of the nose, loss of smell, interference with nasal respiration, epistaxis, &c. Again, the existence of any swelling near the inner canthus will point to extension towards the ethmoid and base of the skull.

Complete Removal of Upper Jaw (Figs. 156 and 157).—The parts having been previously rendered as sterile as possible the patient is brought carefully* under an anæsthetic, and duly propped up, as near to the edge of the table as possible with the head raised and turned over towards the opposite side and downwards as much as is permissible to facilitate the ready escape of blood from the mouth. The surgeon now takes the opportunity of examining more completely the attachments and limits of the growth, and decides whether, owing to its vascularity, it will be wiser to perform a preliminary laryngotomy and plug the back of the pharynx, and to tie the external carotid or place a temporary ligature on the common trunk (*q.v.*).

It will be seen later (p. 489) how unsuccessful this severe operation is in spite of the advances of modern surgery, that a partial factor in the incomplete removal of the disease is the shock and hæmorrhage which lead to the close of the operation being hurried, and further that the high mortality is mainly due to hæmorrhage in patients whose vitality is often very low, and to aspiration-pneumonia. German surgeons—and this

* As in excision of the tongue, the assistant to whom the anæsthetic is entrusted is second only in importance to the surgeon. He should watch most carefully for the first signs of flagging of the pulse, and meet this by injections of ether or brandy. Any evidence of blood going down the throat, dyspnoea (as shown by venous stasis of the cheeks), lividity of the lips, or respiration short and fixed, must also be looked out for. The patient should be brought thoroughly under the influence of the anæsthetic to begin with, and the degree of anæsthesia maintained should abolish the corneal but not the laryngeal reflex. Ether should be given, if there be no contra-indication, until the patient has been well stimulated; after this chloroform, and as little as is absolutely necessary. To aid this, Schlatter (*loc. supra cit.*) advises a preliminary injection of morphia, gr. $\frac{1}{4}$ —gr. $\frac{1}{2}$.

operation seems to continue to be more common with them, than it is with us—and Dr. J. D. Bryant, of New York, are strongly in favour of preliminary ligature of the external carotid, especially in patients exhausted by hæmorrhage and cachexia. Preliminary exposure of the bifurcation of the carotid—for ligature of the external alone does not always suffice—to admit of a temporary ligature being placed around the common trunk has the further advantage of exposing any deep-seated glands that might otherwise have escaped notice. Sir F. Treves and Mr. Hutchinson (*Manual of Operative Surgery*, vol. i. p. 694), consider that “preliminary ligature of a large artery is not a necessary or desirable proceeding. Should, however, the tumour be extremely vascular, a ligature may be placed round the external carotid.” Efficient plugging of the posterior nares is recommended, the division of the bony palate being taken last. I quite admit that this and the following step, which I also recommend save where the patient’s vitality is good, and there is no reason to believe that the growth will be found to be very vascular, take up important time. But the reasons based upon the results of the operation and already given justify the additional time taken, and I would add that the external carotid can always be quickly found by cutting down upon the bifurcation of the common trunk, and then tracing the external carotid from below upwards (*q.v.*).

With regard to a preliminary laryngotomy—not a tracheotomy be it noted—I recommend this on account of the grave risk of aspiration-pneumonia, and for the following reasons. It is a far simpler operation than tracheotomy, and very quickly performed in competent hands. Schlatter (V. Bergmann’s *System of Practical Surgery*, Amer. Trans., p. 726) writes: “It is very properly urged against prophylactic tracheotomy that on account of its danger it is by no means a trifling procedure, and that it deprives the patient of the possibility of expelling mucus and secretions by expiration.” I have already pointed to the difference in the severity of laryngotomy and tracheotomy. With regard to the second objection I would say that having used a preliminary laryngotomy in many cases of severe operations about the mouth, especially in carcinoma of the tongue, I am convinced of its value, and that expiration is but little interfered with afterwards save in feeble patients who already have some bronchitis; just the patients who fall victims to aspiration-pneumonia. I believe that the success of laryngotomy is due to its being performed through a fixed part of the air-passages, and the tube being removed as soon as the operation is finished.

The surroundings of the surgeon will largely aid in a decision on these points. If he does not make use of a preliminary ligature of the external carotid and a laryngotomy, he must be aided by efficient assistants ready at all points with sponge-pressure, necessary movement of the patient’s head, and with the anæsthetic. He must plug the posterior nares efficiently, removing the plugs before the bony palate is divided, and he must not forget the possibility of infiltrated deep cervical glands.

One more preliminary step
the operation take place
the external carotid
position for the operation

Prof. Keen in excision of the larynx, is worth a trial, but might cause much venous congestion of a vascular growth.

The incision, which goes by the name of Sir W. Fergusson,* is then made through the centre of the lower lip (an assistant controlling the opposite coronary while the one in the flap is commanded by the surgeon himself), round the ala, up along the side of the nose to the inner canthus, and outwards just below the margin of the orbit, as far as the malar prominence. Where the disease is extensive, the incision may have to go further out; on the other hand, where it is not needful to remove the orbital plate, this part of the incision may be dispensed with more or less. The angular vessels and lateralis nasi will give the most trouble before their bleeding is entirely checked. The

FIG. 156.



Removal of upper jaw. (Earlier stage.)

Reflection of the flap, and section of the bones. The extraction of an incisor was not needed here.

flap thus marked out is then reflected, and wrapped in sterilised gauze. The hæmorrhage is often free, especially in cases of rapidly growing tumours which have thinned the bone. Spencer Wells's forceps are applied to the larger of the vessels; when the flap has been reflected, care being taken not to cut into the growth, these are secured, and an assistant makes pressure—plenty of sterilised pads on holders must be at hand—upon the flap to arrest oozing while the surgeon divides the bones in the following order, the ala of the nose being first detached from the bony surface, and the periosteum of the floor of the orbit detached from the bony surface and pushed backwards as far as the spheno-maxillary fissure if the whole bone is to be removed; during this step the origin of the inferior oblique is raised with

the periosteum, and the eyeball and fat are protected with the copper spatula.

(1) The junction of the jaw with the malar bone is divided. The line for the saw is marked out with the knife upon the bone just in front of the origin of the masseter. With a narrow strong-backed saw (Gant's or Adams' osteotomy-saw) (Fig. 163) this line is converted into a deep groove and the rest of the bone quickly severed with forceps, the left forefinger placed upon the margin of the orbit steadying the instrument used and preventing any damage to the eye. This bone section is practically in a line with the spheno-maxillary fissure (at the lower and outer part of the orbit), and should fall into it. This will preserve the prominence of the cheek. If the malar bone be involved the zygoma must be sawn through. Schlatter advises the use of a

* First recommended by Dieffenbach. Its advantages are very great—viz., (1) only the terminal branches of the facial nerve are divided; (2) only branches of the facial vessels, not their trunks, are cut; (3) the scar left is much less conspicuous, as the incisions are placed in the natural feature-folds.

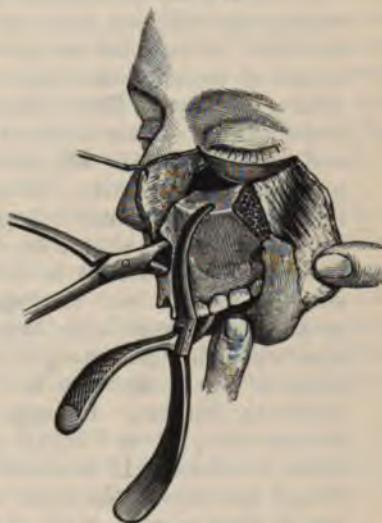
Giglis' saw (Fig. 132). This delicate instrument inflicts very little damage on the soft parts, and cutting away from the growth is not likely to injure it. It is carried on a half-curved needle through the spheno-maxillary fossa and over the exposed surface of the malar bone.

(2) The nasal process of the superior maxilla is next severed by cutting a saw-groove across it, and then placing one blade of the forceps inside the nostril and the other within the orbit as far as the spheno-maxillary fissure, the soft parts being first a little freed and carefully kept out of the way with the left thumb-nail. This bone section may be also made with a chisel and mallet. In either case there must be no splintering.

(3) The central or a lateral incisor being next drawn—this step is always to be left till now, to save needless bleeding—the mouth is widely opened with a gag, an incision made with a stout scalpel along the middle line of the hard palate up to the teeth and over the anterior aspect of the alveolus into the nostril, and another transversely outwards at the junction of the hard and soft palate, towards the molar teeth on the side affected. The soft palate is then detached with a scalpel or blunt-pointed scissors, and thus preserved when the bone and growth are wrenched away. The hard palate is next deeply notched with the saw introduced through the nose opposite to the tooth which has been drawn, and severed with long bone forceps, one blade of which is introduced within the nose, and the other into the mouth. If a Giglis' saw is used here, it is passed from the nose into the mouth with a curved probe. If a chisel or osteotome be now inserted into the different lines of bone section, the bone is loosened with a series of quick and careful levering movements, while, finally, lion-forceps being made to bite firmly into the hard palate and the malar aspect of the bone, in the manner shown in Fig. 157, the bone is detached by a few wrenching, rocking movements upwards and downwards and laterally, the left forefinger detaching any soft parts which retain the bone, and the superior maxillary nerve being cut cleanly with scissors. If the above-mentioned sections have been properly made, the difficulty in detaching the bone lies in the pterygoid and palatine processes. The introduction of curved cutting bone-forceps behind the tuberosity of the maxilla, not on the inner side as in Fig. 157, will help now.

When the bone has been much invaded by disease, or in the case

FIG. 157.



Removal of upper jaw. (Later stage.) The flaps are reflected and held aside. The bones have been divided. The upper jaw is being disarticulated with the lion-forceps while a pair of cutting bone-forceps completes the division of the palatine attachments. (Heath.)

of an aged dead body, it is very likely to come away in fragments, being unavoidably crushed down by the forceps.

On the removal of the bone, hæmorrhage is often free from the palatine and other arteries, especially in a case of rapid growth. A large sterilised pad is at once thrust into the cavity, and pressure efficiently made. If on its withdrawal any vessel still spirts, it is usually easily tied, owing to the large size of the gap. The pterygoid fossæ, the cavity of the nose, and the palate are next examined, the sharp spoon or gouge being applied to remove any remaining portions of disease, or Paquelin's cautery, zinc chloride paste, or strong formalin made use of to destroy what cannot be otherwise removed.

If there is any doubt about a part of the growth having been left behind, and if zinc chloride paste or strong formalin are used (p. 434), these had best be inserted on gauze, the strips being brought out of the mouth at the angle and tied together with silk, and so readily removed after a few days. But if the bone has come away with all the growth, if the surface of this is smooth and encapsuled, not ragged or lacerated, and the bleeding is all arrested, the surgeon will do best to insert nothing into the cavity. If oozing is going on, or if there is reason to fear intermediary hæmorrhage, strips of sterilised gauze wrung out of iodoform emulsion should be carefully packed in, and removed later on by the mouth. But it is difficult to keep even these sweet, and the surgeon will do best to dispense with any plugging if possible, and to content himself with brushing over the wound with a solution of zinc chloride (gr. 40—3j.), or Whitehead's varnish (p. 605). The edges of the wound are then brought together with salmon-gut and horsehair sutures. Especial care should be paid to adjusting two points—one, the red line; the other, the angle of the flap near the inner canthus. If necrosis take place here, ectropion will follow. When the edge of the lip is united the suture should be left long and the lip thus everted, while its mucous surface is carefully stitched with sterilised catgut or horsehair sutures, left long in the latter case. A few strips of iodoform gauze sterilised in carbolic acid are then laid along the line of incision, with transverse ones across the divided lip, so as to give additional support here; they are kept in position with iodoform and collodion.

A few points require further attention. The dropping of the eye from the removal of the orbital plate, and probably also all the attachments of the suspensory part of Tenon's capsule (Lockwood), and the harmful results which may follow, are alluded to below (footnote, p. 488). In a favourable case, the surgeon having divided the periosteum, may be able with saw or chisel to leave the greater part or even the whole of the orbital plate. Where all this bone must go, the suggestion of v. König may be followed. This surgeon takes a strip of the temporal muscle, half a finger's breadth, together with a piece of the anterior border of the coronoid process chiselled off at its junction with the horizontal ramus. To give support to the eyeball, the strip is carried below and around it towards the nasal wall, where it is sutured to the remains of the frontal process of the maxilla. As malignant growths may proliferate into the orbit without any disturbance of the eyeball, Schlatter (*loc. supra cit.*) advises that in extensive cases the patient's consent be obtained to removal of the eyeball.

As it is most important to shut off the cavity of the wound from that of the mouth as much as possible, and as plugging is painful and the plugs soon become infected, the soft palate, where clearly sound, united with sterilised catgut to that over the hard palate, which is raised in the same way as in the operation for cleft palate, should be sutured to the line of division of the mucous membrane on the inner aspect of the cheek. If plugging has now to be resorted to, some of the strips must be brought out through the nose, the others by the mouth.

During the after-treatment the patient should be kept well propped up to facilitate the escape of discharges, which must be prevented from collecting by frequent syringing, or, what is better, by the patient himself often rinsing and gargling his mouth and wound with some safe antiseptic solution, *e.g.*, chinisol, boroglyceride, potassium-permanganate lotion, or one of spirit of wine, 3ss. to a tumbler of water. The wound inside should be, if needful, occasionally brushed over or sponged with formalin. The patient should be fed with nutrient enemata and a soft tube for the first few days. Especial care is needed to cleanse the mouth after food is taken. If possible, patients should be got out of bed into an armchair within the first week.

In those cases, rare nowadays, where the growth is of great size, owing to the operation being deferred, the mouth may remain open for some days after, but the power over the muscles which raise the lower jaw is gradually regained. The lost sensation is usually restored, and the resulting deformity is often very slight.* Later on, when the parts are soundly healed, the skill of a dentist is called in to fit on a tooth-plate,† and obturator, if needful. The deformity due to the falling-in of the cheek may be remedied by the injection of paraffin (p. 463).

Partial Extirpation of the Upper Jaw.—Operations for removal of an epulis with the alveolar border have been described at p. 476, and one for opening up and exploring the antrum is given at p. 501.

If the surgeon find that the lower part only of the upper jaw need be removed, abundant room will be given by dividing the upper lip in the middle line, prolonging this round the columella into the nostril on the diseased side. By detaching the nose and dissecting up the flap of cheek, the facial surface of the jaw can be well exposed.

Again, if, after exposing the whole jaw by Sir W. Fergusson's incision, the surgeon find that the orbital plate can be spared, a horizontal saw-cut is made just below the infra-orbital foramen, and the bone cut through with a chisel and a few taps of a mallet.‡

* No skin is, of course, removed, even if it appears to be very redundant; it rarely sloughs, save when the stretching has been extreme, or when it has been needful to apply the cautery to the flap. When the growth has invaded the skin over it, a hideous fistula is left, which must be closed later on, if the patient survives, which he seldom does in these cases; or, if the vitality be very low, a flesh-tinted artificial cheek, supported by spectacles, must be worn. Messrs. Watson Cheyne, C.B., and Burghard point out that this has the great advantage of allowing the inspection of the cavity, and timely application of any needful cautery or caustics.

† Mr. Butcher (*loc. supra cit.*, p. 270) in one case preserved the last molar tooth and part of the tuberosity as a fixed point for a tooth-plate, intending to have removed this if the disease recurred in it subsequent.

‡ The orbital plate should

be preserved. As Mr. Butlin

When the orbital and nasal parts of the upper jaw are involved and the lower alveolar portions are sound, these latter may be thus preserved. A cheek flap being reflected by an incision through the lip and upwards to the inner canthus along the nose, the nasal and malar processes are divided while the eye is duly protected. A horizontal saw-cut is then made above the alveolar process, outwards from the nose, and another carried upwards from the outer end of this, to join the incision through the malar process, being made either with the saw or chisel. The piece of bone thus mapped out is loosened with a chisel or elevator, and either prised out with the latter instrument, or wrenched downwards and outwards with the lion-forceps.

Several other operations involving partial removal of the upper jaw are given under the treatment of Naso-pharyngeal Fibroma (p. 495).

Difficulties and Dangers during the Operation.—These have been already alluded to: the chief are—

1. Shock.
2. Hæmorrhage.
3. Breaking down of the bone in the lion-forceps.
4. Outlying pieces of growth either in the pterygoid or other fossæ, or in the temporal region, or far back in the roof of the nose.

Possible Causes of Failure.

1. Prolonged shock. Inability to rally. All the usual details, before, during, and after the operation, should be attended to. Feeding with a tube passed by the mouth or by the opposite nostril should be early resorted to, especially in the case of elderly patients, or in those much run down.

2. Secondary hæmorrhage. If this be severe, resisting the use of ice, etc., the wound must be opened up, and, if no definite bleeding point be found, firm plugging must be resorted to, either with iodoform gauze wrung out of carbolic acid lotion (1 in 20), or the same, with the ends in the wound, wrung out of adrenalin chloride (1 in 1,000), or turpentine. These steps failing to arrest the hæmorrhage, ligature of the external or the common carotid must be employed.

3. Infection of the wound. Different forms of this grave complication are likely to set in when the patient is aged or much broken down in health, with impaired viscera, or when, owing to extensive removal of bone—*e.g.*, having to saw through the zygoma and loosen the outer wall of the orbit—the surgeon opens up deep planes of cellular tissue, which cannot, from the surroundings, be kept aseptic, most troublesome burrowing in the neck probably following. To cut cellulitis short, free scarification with small incisions should be made use of early so as to unload the parts, and abscesses should be opened at once. Boracic acid fomentations should be early employed.

4. Inhalation-pneumonia is here, as after removal of the tongue, a decided risk. In this case, also, the treatment is mainly preventive, attention being assiduously paid to all the details already given, before, during, and after the operation.

p. 125) points out, when the floor of the orbit has been removed there often results not only serious disfigurement, but much œdema of the lower lid, and an unhealthy condition of the eye itself, which may be destroyed. Paralysis of the lower part of the orbicularis and epiphora from damage to the lachrymal duct are, also, not uncommon sequelæ.

5. Inflammation of the brain or its membranes.

Mr. Butlin (*loc. supra cit.*) has shown that the mortality after removal of the upper jaw is nearly 30 per cent. He goes on to remark that, if we are to reduce this mortality, "we must adopt two courses in the after-treatment—first, such means as will render the wounds aseptic; second, regular and sufficient administration of food."

The recent experience of German surgeons bears out the above. Schlatter (*loc. supra cit.*) writes: "How little the antiseptic era influenced the prognosis of this operation is shown by a comparison of Rabe's and Kronlein's compilations. The former collated 606 cases of major operations upon the upper jaw between 1827 and 1873, and found a mortality of 18.4 per cent.; while Kronlein calculated a mortality of 21.5 per cent. from 158 total resections taken from the antiseptic period, 1870 to 1897. König estimates the mortality at about 30 per cent." Kronlein in his most recent communication has shown the cause of failure in the latter cases to be diseases of the air passages, not wound injuries. More than half the deaths after this operation are referable to these complications, especially aspiration during anæsthesia.

6. Recurrence.

With regard to this Mr. Butlin considers the prospect as very gloomy, only four cases out of sixty-four (in which the result is recorded) being able to be considered relatively successful—*i.e.*, having remained cured for three years.

This opinion is again fully borne out by the results of German surgeons. Thus Schlatter writes, at Zurich, he "observed recurrences after an average of 3.9 months in all cases of malignant tumour involving the entire jaw." Küster recorded no permanent results. In the Erlanger statistics one permanent cure was recorded in seventeen cases. In the Griefswald statistics, of seventeen cases there was not one permanent cure. Estlander found ten reappearances in sixty-two operations. In the Gottingen clinic of seventy-four total resections, with twentieth-three deaths, Martens found ten permanent cures. Stein has recently reported, from Von Bergmann's clinic, that of thirteen total resections for carcinoma, between 1890 and 1900, not one of those whose record is obtainable is living at the present time." The prognosis in sarcoma is more favourable than in carcinoma. Out of my five cases of removal of the upper jaw I only know of one that was permanently cured. The patient was a young servant girl; the growth was proved microscopically to be a spheroidal-celled carcinoma. Seven years afterwards the deformity was extremely slight, and owing to the skill of a dentist, mastication and articulation were little interfered with.

OPERATIONS FOR NASO-PHARYNGEAL FIBROMA* OR SARCOMA, AND MALIGNANT GROWTHS OF THE NOSE.

(Figs. 158 to 162.)

Naso-Pharyngeal Fibroma or Sarcoma. Attachments.—The surgeon should consider these ca

* The usual name, "naso-pharyngeal polypus," should be avoided. Anything like a pedicle is often absent (Fig. 158). V.

what operation he will adopt for one of these most dangerous growths.

They will vary according to the duration of the growth. The primary attachments start by far most frequently from the base of the skull, arising in the thick periosteum invested by mucous membrane which covers in the roof of the nose and top of the pharynx, especially the adjacent parts of the basi-sphenoid and basi-occipital. Less frequently they may arise in the pterygoid fossæ and adjacent plates, or from around the posterior nares. Dr. Sands* points out that the region in which a naso-pharyngeal fibroma can originate is one of narrow limits, corresponding with the margins of the posterior nares

FIG. 158.



Naso-pharyngeal fibroma springing from the base of the skull. In the sphenoidal sinus is seen a smaller growth. (Massé.†)

and the summit of the pharynx. It is thus one that can be satisfactorily explored with the finger, and by this means a growth should be detected in its early stage and removed safely while yet small. Where the growth is a sarcoma, owing to the structure of its vessels, and its tendency to ulceration, a preliminary examination may cause severe bleeding.

While the above are the most frequent *primary* attachments of the growths, it should always be remembered that when one of these

is a better one, but this term must not exclude the co-existence of sarcoma, any more than this can be excluded in the so-called "fibrous epulis."

* "On Naso-pharyngeal Polypi": Dr. Brown-Séquard's *Arch. of Sci. and Pract. Med.* No. 6. According to Dr. Sands, these fibromata may also spring from the apex of the petrous bone and the great wing of the sphenoid. Any intending operator will also do well to consult a very practical paper on this subject by Mr. Stonham, *Westminster Hosp. Rep.*, vol. iv. p. 61.

† *Thèse de Polypes naso-pharyngiens.* Paris, 1864.

fibromata has existed for some time, when they are sloughy, when previous attempts have been made to remove them—under these conditions the growth is very likely to have taken on *secondary* attachments. A common instance of these is seen when a growth springing from the base of the skull forms adhesions to the pterygoid fossæ.

If secondary attachments are made out to exist, the next question will be, how far are these intimate and close? How far is the growth not only in contact with, but how far has it actually absorbed bones, such as those of the nose? How far has it got into the antrum, and thus come to resemble closely a growth of the upper jaw? Again, swelling of the cheek, with protrusion of the eye, will point to an operation, osteoplastic or otherwise, on the upper jaw. In the same way extension of the growth into the zygomatic and temporal fossæ will render the prognosis unfavourable. Finally, any symptoms pointing to softening of the base of the skull and implication of the membranes—*e.g.*, headache, tendency to coma, convulsions, with evidence of pyrexia, will be conclusive against any operation, even when most carefully performed. On the other hand, where the evidence merely points to the threatening of meningitis, it may be possible to prevent this by an operation.

The site and width of the attachment of these growths having been spoken of, it remains to call attention to one or two practical points in their structure. While usually fibromata at first, and often so throughout their course, they can make their way like sarcomata through adjacent bony walls. Metastases are, I believe, rare. The growths are often very vascular, especially from the character of their veins, which have no sheath, and, therefore, cannot retract when divided, and which often assume the character of cavernous tissue; hence the readiness with which they bleed, even when touched with a probe. Large growths are prone to ulceration on the surface, hence another cause of hæmorrhage, and also of infection. From their tendency to occur in about the decade from fifteen to twenty-five, epistaxis, and any evidence of nasal obstruction at this age, should always call for an early examination of the naso-pharynx.

Methods of Removal.—Several will be given owing to the great difficulty of exposing the root of the growth. On the whole the best method is that through the upper jaw, as this promises to give the best access in the largest number of cases. The three methods first given are rarely to be adopted. They are only suited to small growths, those of the nature of myxo-fibroma—for all varieties of fibroma are present here—those with a distinct and narrow pedicle, which can not only be reached but also commanded (two different things), and cases where no secondary adhesions have been contracted.

(i.) **Avulsion.**—This method, tearing away with suitably curved forceps introduced either by the nose or by the mouth, aided in either case by a finger passed behind the soft palate, is only suitable to the above cases, and in none is it without danger. Mr. Cooper Forster's interesting case (*Clin. Soc. Trans.*, vol. iv. p. 159) is a striking instance of this.

Attempts having failed to
duce a pair of blunt-
to fill the palm of t

n, Mr. Forster intro-
large pieces, enough
a great deal of

force to detach them. There was much hæmorrhage. Severe headache quickly followed, then aphasia, restlessness, convulsions, and death on the twelfth day. General arachnitis was found, with sloughy softening of the brain about Broca's convolution. The growth occupied the left side, filling the space between the greater and lesser wings of the sphenoid, the orbital plate of the frontal, and the cribriform plate of the ethmoid.* From the nasal fossæ it has extended by the sphenoidal fissure into the back of the orbit, but without damaging the optic nerve. The cribriform plate of the ethmoid was broken, there being a small opening at its back part from which a fracture extended forwards. This fracture had doubtless been effected while the growth was being torn away.

The serious hæmorrhage,† and the probable incompleteness of the operation, are also strongly against making use of avulsion. Here, as elsewhere, removal, piecemeal, of a growth is most unsatisfactory, either malignant, or on the high road to become so.

(ii.) **Ligature.**—This again is only suitable to very few cases, *e.g.*, where the pedicle is distinct and fairly thin, and where the growth is not very vascular, *e.g.*, a myxo-fibroma, and where it has contracted no adhesions. In less suitable cases, in addition to the probability of return in the root, the infection and fœtor which accompanies the sloughing process is a most serious drawback.‡ The patient's head being brought a little over the edge of the table, so that the blood shall escape readily, the mouth is opened with an efficient gag. A loop of wire sufficiently stout and softened is most carefully adjusted round the attachment of the fibroma, having been passed by the nose, and aided by a finger behind the soft palate. The *écraseur* is then fitted on, and the wire tightened very slowly. Spare wires should be at hand. Ether should be given first, and then chloroform by the nostril. Care must be taken in such cases to prevent the growth, when the pedicle is divided, falling upon the larynx. The artificial nail (p. 471) would, perhaps, be an efficient means of dealing with the stump of the pedicle. Strong formalin should be applied to this.

(iii.) **Galvanic Loop.**—Here, in the very few cases where this method can be tried, the pedicle would be left, unless the surgeon possesses special instruments, such as the post-nasal galvano-cautery, and experience in using it. It would be well to have a galvano-cautery at hand, with platinum points of varying size to destroy a stump that bleeds persistently, after removal by other means.

(iv.) **Electrolysis.**—This method, while most tedious and uncertain, is adapted to certain cases. Thus when patients are weakened by repeated bleeding it is justifiable to use electrolysis in order to arrest the hæmorrhage, and thus either to reduce the growth sufficiently in

* It is noteworthy that though this large growth (Mr. Forster describes it an "enormous mass around which it was impossible I could get the wire") thus extensively implicated the base of the skull, it only appeared externally as a firm, fleshy polypus filling up a large part of the left nostril, but apparently not pressing much upon the right one. There was no deformity of any part of the face, no fulness of the palate, nor any projection in the throat.

† According to Dr. Sands, Dupuytren lost a case from hæmorrhage after an attempt to remove a fibroma by forceps, in which he succeeded in removing only a few fragments. If this method is ever made use of, it would be wise to first perform laryngotomy, and plug the fauces with a sponge.

‡ Dr. Sands quotes other causes of death as not infrequent—viz., suffocation from detachment of the growth, pyæmia, and œdema of the larynx.

size to allow of its being removed through the natural passages or to obliterate it altogether. It may also be used as an auxiliary. Thus, Dr. Sands suggests that, after removal of the growth, its pedicle might be successfully treated by electrolysis.

Professor Kummell (V. Bergmann's *System of Practical Surgery*, *Amer. Trans.*, vol. i. p. 794), who describes these fibromata as benign and believes that if adolescence be reached a certain degree of spontaneous disappearance may safely be counted upon, advises electrolysis especially when the growth is small, or when the patient has almost reached adolescence. With regard to any importance to be attached to age I know of no facts which support the above belief and that would justify our delaying operation. As a rule, hæmorrhage, infective conditions such as pyæmia, septicæmia, meningitis, exhaustion from hæmorrhage, interference with respiration and deglutition, carry off the patient if nothing is done. Electrolysis is most effective when the negative pole consisting of one or two needles of steel or platinum-iridium covered with shellac to within a short distance of their points, is plunged deeply into the tumour, while the positive pole as a broad plate is placed on or near the sternum. A rheostat should be employed and the current gradually increased from 0 to 10-30 milli-ampères, this being the extreme amount which can be endured without anæsthesia. In from five to fifteen minutes considerable disintegration takes place in the interior of the tumour, the needles become loosened, and when the current is gradually turned off, they can be removed without bleeding.

(v.) **Excision by an Operation involving Removal of Bone, Osteoplastic or otherwise.**—These cases may be divided as follows :

- A. Those in which the attack is made through the mouth.
- B. Those where the attack is made through the nose.
- C. Those in which the attack is made by removing the upper jaw, partially or completely, or by resecting this bone osteoplastically.

A. *Operation for Naso-pharyngeal Fibroma through the Mouth.*—This operation was strongly advocated by M. Nélaton. It consists in slitting the uvula and soft palate exactly in the middle line from before backwards, then prolonging this incision along the centre of the posterior half of the hard palate, going here down to the bone ; from the end of this incision two others are made slightly obliquely outwards towards the teeth, also going down to the bone. The flaps, together with the periosteum, are then detached, so as to form nearly rectangular flaps.* Two large holes are next drilled through the hard palate, each well to one side of the middle line, the intervening bone is cut away by placing the ends of cutting-pliers in each of these holes, and, by making lateral cuts back to the free border of the hard palate, a rectangular portion of the posterior half of the bony vault is removed. The mucous membrane and the periosteum on the upper surface of the bone, which will now be found detached, are divided, and, if it be needful to get more room, more or less of the vomer is cut away. Room being thus obtained, the fibroma is removed and its attachment dealt with. If all the growth is got away satisfactorily, the palate

* This detachment is, as is well known in staphylocoma junction of the palates, and is best effected by raspatoi

riorly, at the

flaps are united in the ordinary way; if further treatment is required, staphylorrhaphy must be performed later.

Preliminary laryngotomy should be performed owing to the proximity of the larynx.

The advantages of this operation, when contrasted with removal of the upper jaw, are at first sight considerable.

(1) There is no deformity left on the face; (2) the parts cut through are less important; (3) mastication is not interfered with by removal of the teeth; (4) the operation is said to be less difficult; (5) the hæmorrhage is claimed to be less,* no large vessels being cut through; (6) the growth is attacked directly; (7) through the gap thus left the surgeon can again attack the growth, within a few days if he has been unable to complete the operation, or later on if reappearance takes place; (8) the gap can easily be dealt with later on by staphylorrhaphy, or by wearing an obturator.

The first three advantages are, no doubt, of great value if the growth can be entirely dealt with by this method; otherwise, considering the malignancy of these growths, the inveterate way in which they reappear, if incompletely dealt with, neither surgeon nor patient would be wise in running great risks for the sake of what one may call rather æsthetic advantages.† There is no doubt that, in a few cases, to be mentioned a little later, where the polypus is of moderate size, distinctly pedunculated, and attached low down—*e.g.*, about the posterior nares, or well forward on the base of the skull—the operation will be easier, the hæmorrhage will be less, and the growth will be more directly attacked. The advantage of a future staphylorrhaphy is, like those given first, not of sufficient value to recommend this operation if it is wanting in others more important.

Turning to the cases themselves, Dr. Robin Massé has collected twenty-six treated by this method, twelve having been under the hands of M. Nélaton himself. Of these twenty-six, thirteen are said to have been successful, but it is not stated for how long they were followed up. In one case, in which the after-history is given, a small reappearance took place two years later from the pedicle, and was destroyed. While

* This is very doubtful. Bleeding from the divided and partially resected palate will be very near the aperture of the larynx. Again, if troublesome hæmorrhage take place from the root of the fibroma, it will be more difficult to deal with it by this route than by the nasal or maxillary routes, or by a combination of these. Dr. Sands (*loc. supra cit.*), in removing a fibroma by this method, had surrounded, without difficulty, the pedicle with an *écraseur* chain. This breaking, the pedicle, which was stout and firm, was divided with scissors as close to the skull as possible. Copious hæmorrhage followed, and much time was consumed in unsuccessful attempts to secure a large artery which had retracted to the deepest part of the wound, and which was inaccessible to the ligature. The bleeding finally ceased in consequence of the prostration of the patient, who had several alarming attacks of syncope. The growth reappearing, it was removed by the method of Maisonneuve. Though it was not thought prudent to attempt the removal of a small prolongation which ran into the sphenoidal sinus, no reappearance had apparently taken place nine months later.

† I may here draw attention to the great frequency of these fibromata in males, in whom the growth of hair will largely conceal the facial deformity consequent on operations through the upper jaw. In young patients where the mouth is small and the growth large, this operation will be out of the question.

suited to the cases mentioned above, the method could scarcely be made use of successfully in large polypi, in the case of those with secondary attachments or large sessile bases, or in the case of those which have extended into the pterygoid fossæ, or, in fact, beyond the naso-pharynx. Save by French surgeons, it does not appear to have been much used, from the belief that the space given is too limited.*

Dr. Sands points out that, in the majority of the cases in which surgeons have operated through the palate, they have had to leave the wound open in order to remove the pedicle later. This step is by no means so easy as might be imagined, and in many cases the surgeon has been driven later to make use of another operation when the patient's condition was less satisfactory. Furthermore, repeated irritation, in the shape of attempts at destruction of the pedicle with caustics, the cautery, &c., is too likely to result in rapid sarcomatous growth.†

B. *Operation for Naso-pharyngeal Fibroma through the Nose, and for Malignant Growths of the Nose.*—Under this heading will be included :

- | | |
|---------------------------------|-----------------------------|
| (1) Furneaux Jordan's operation | (4) Langenbeck's operation. |
| (2) Lawrence's operation. | (5) Rouge's operation. |
| (3) Ollier's operation. | |

These operations through the nose are only suited to cases in which the disease is well within reach. They may also be used in doubtful cases for exploratory purposes. In case of naso-pharyngeal growth, as the room which they give, and the access which they afford, will probably be found insufficient, additional room must be obtained by removal of part of one or both maxillæ.‡

(1) Furneaux Jordan's Operation.—I prefer this, when available, to

* Mr. Stonham (*Lancet*, Jan. 7, 1888) has recorded a case of naso-pharyngeal fibroma, in which "the soft palate was divided in the middle line, and an attempt made to remove the growth through the mouth; but this plan failing to give sufficient room, the nasal cavity was opened up," and the growth thus successfully removed. Mr. Southam found that division of the soft palate gave insufficient access to the broad base of the growth; attempts to turn the upper jaw out still gave insufficient access; removal of this bone, the orbital plate being left, was followed by a good result. The sphenoidal sinus was opened and plugged. Mr. Walsham (*Med. Soc. Trans.*, vol. xix., 1896, p. 394), speaking in favour of this operation, said that he had had to deal with growths of this kind on several occasions, and had always succeeded in obtaining adequate exposure by splitting the soft and cutting away the hard palate. He pointed out that these growths, though they may extend into the nose, and even cause the eyeball to protrude, do not usually involve the turbinals or upper jaw; there was consequently, as a rule, no need for turning the jaw outwards to get a good exposure. Mr. Wallis (*ibidem*) also remarked on the excellent exposure which this method afforded him in a case of large naso-pharyngeal growth attached to the internal pterygoid plate. Prof. Annandale (*Lancet*, Jan. 26, 1889) reports three cases in which, after division of the hard and soft palate, the maxillæ were forcibly separated. The gap attained was very limited, only half to one inch. The results are not encouraging.

† Dr. Sands points out that the deep situation of the growth, and its position near the larynx, render the use of caustics both difficult and dangerous.

‡ M. Hergott (*Gaz. des Hôp.*, 1867, p. 97), in the case of a fibroma reappearing after treatment by ligature, tried curetting the point of implantation on the base of the skull. He found that an instrument passed through the anterior nares impinged exactly upon this point; the bone was easily denuded, and seven months afterwards no trace of reproduction was visible.

any other by the nose. It is extremely simple, most efficient (especially when a growth has dilated the nasal cavities), and leaves most trifling scars. An incision like Sir W. Fergusson's being made along the side of the nose and through the lip, the nose is detached from the bone, and, the septum being cut through, is turned over on to the opposite side of the face. It is best adapted to nasal polypi of sarcomatous nature, and limited to one side; for naso-pharyngeal fibromata it does not give sufficient room.

(2) Lawrence's Operation.*—In this, the back of the nasal cavity is exposed and got at by turning up the nose.

The integuments are first divided on each side of the nose by an incision beginning at a point just internal to the lachrymal sac, and carried down to the junction of the ala and the lip, across the upper lip, and then up to a corresponding point on the other side. Next, the



Ollier's operation.
(Bismarck and Kowalzig.)

incision is completed by cutting through the nasal bones and the nasal process of the superior maxilla with bone-forceps. The septum being now divided with strong scissors, the nose is turned up and the posterior part of the cavity exposed.

(3) Ollier's Operation through the Nose † (Fig. 159).

In this method the nose is, by an incision somewhat like the last, turned not up but downwards. M. Ollier begins his incision at the edge of the bone, close behind the ala of the nose, carries it upwards along its side to the highest part of the depression between the eyes, then across, down to the corresponding point on the other side. The bone is sawn through in the line of the incision, the necessary liberating incisions made in the septum and the sides, and the nose turned down. The septum is pressed aside, the growth removed, its base of implantation curetted or cauterised, and the nose replaced.

A modification which is sometimes desirable on account of the size of the growth, or its site of its implantation, is indicated in Fig. 246. The incision is made obliquely outwards upon the cheek, and a transverse one is made from each end inwards to the ala of the nose. The bone is divided in the direction of the skin incisions—in the oblique one, as before described; in that which is horizontal, by passing a fine saw across the nostrils, through holes made between the bone and cartilages, and sawing outwards. This line of section must be high enough to avoid the roots of the teeth.

Mr. Stonham, who has used Lawrence's operation three times successfully, prefers it to Ollier's as the nose is turned upwards, and is thus not in the way of the operator. Again, the nasal bones, though broken across, are still attached by periosteum, and do not therefore run much risk of necrosing.

* *Med. Times and Gaz.*, 1862, vol. ii. p. 491.

† A case by Dr. Rochard and Dr. Gougenheim, in which very large sequestra, due to tertiary syphilis, were successfully removed by Ollier's operation, after Rouge's operation had failed, is reported in the *Ann. de Malad. de l'Oreille, du Larynx, &c.*, Oct., 1896.

(4) v. Langenbeck's Operation by Excision of the Nasal Process of the Upper Jaw (Fig. 160).—A curved incision, with the convexity forwards, is made from the inner edge of the eyebrow on to the bridge of the nose, and thence downwards into the naso-labial fold. The flap of skin thus marked out is then dissected up in a backward direction. The nasal cartilage having been severed at its junction with the bone, a short, strong, narrow-bladed finger-saw is inserted into this opening, and the nasal process of the upper jaw is sawn through up to the lachrymal sac; the saw is next carried inwards through the roots of the nasal process of the superior maxilla and the nasal bone, and lastly downwards through the nasal bone itself. The removal of this sawn-out lamella, consisting of the nasal process of the upper jaw, part of the lachrymal and the nasal bone, gives space enough for inspection of the whole interior of the nasal cavity, the posterior nares, and the lower portion of the body of the sphenoid bone.

Though, as a rule, no deformity of the face follows on the removal of this piece of bone, von Langenbeck modified this operation into an osteoplastic one. Thus he sawed through the nasal process covered with the periosteum only, as far as the lachrymal bone, and upwards through the nasal bone, then inserting an elevator he raised the thin bony flap, which gave a way above. At the close of the operation this flap was replaced.



FIG. 160.

v. Langenbeck's operation of resection of the nasal process and nasal bone. (Esmarch and Kowalzig.)

(5) Rouge's Operation.—This has already been described at p. 465.

C. Operations for Naso-pharyngeal Fibroma by Removal of the Upper Jaw—(i.) completely; (ii.) partially; or (iii.) by osteoplastic operation on this bone.

(i.) Complete Removal of the Upper Jaw.—This has already been fully described (p. 482).

(ii.) Partial Removal of the Upper Jaw.—These operations are very numerous; one or two will be given as specimens.

Of these operations the second is to be preferred. Removal of the entire jaw is not usually needful. The orbital plate can be left. The objections to the osteoplastic method, which are considerable, are given below (p. 498). Removal of the lower portion of the jaw will give a good exposure, especially if the surgeon combines it with a simultaneous attack through the nose, if needful. As the orbital and malar processes are left, the subsequent disfigurement is slight. The skill of the dentist will meet the sacrifice of the alveolar portion.

a. Method of Maisonneuve* and Guérin.†

Dr. Robin Massé (*loc. supra cit.*, p. 51) states that the so-called operation of Maisonneuve is really that of Guérin, with a modification in the division of the soft parts. The e

* *Gaz. des Hôp.*, 21 Août, 1860.
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† *Élém. Chir. Oj*

is to get room for attacking the fibroma by removal of the lower part of the jaw. This bone being sufficiently exposed by raising the soft parts over it—and for this purpose the method of Sir W. Fergusson seems superior to those given by the above French surgeons—the hard and soft palate are then divided in the middle line, and the soft detached transversely on the side to be operated upon. The hard palate is next divided in the middle line by saw and bone-forceps, working from the nose into the mouth. By a transverse section with a narrow-bladed saw introduced into the nose, or a chisel, and made to cut horizontally outwards, the facial aspect of the bone is divided as far as the maxillary tuberosity.* The lower part of the jaw is then strongly depressed, and thus detached, consisting of the alveolar and palatine processes, a portion of the body, and a varying amount of the pterygoid processes which usually comes away with it. The fibroma is then extirpated.†

b. Method of M. Béraud.

In this the upper, not the lower, part of the jaw is removed, so as to preserve intact the teeth and alveolar process of the palate.

In all these operations hæmorrhage may have to be met by a preliminary laryngotomy and plugging the fauces (pp. 614, 624); and also, perhaps, by a ligature of external or common, permanent or temporary, carotid (p. 613. See also Ligature of these vessels).

(iii.) *Osteoplastic Operations on the Upper Jaw.*—In this the bone is cut through by various incisions, turned in different directions on some uncut attachments, as on a hinge, and then fitted down again after the removal of the growth.

Method of Prof. Langenbeck‡ (Figs. 161, 162).—This is one of the best known of the above operations. Its object is to get at the fibroma, especially if it be one in the pterygo-maxillary fossa, without interfering with the alveolar and palatine processes or with the orbital plate. While this operation seems well suited to its object, its drawbacks are certainly considerable, for (1) there is the great difficulty of raising so fixed a bone, and again of getting it evenly into place—thus the operation is prolonged and the hæmorrhage very severe; (2) if the upper jaw has to be sawn from behind forwards, this cannot be done easily unless the fossæ at the back of the jaw and the sphenopalatine foramen are much dilated; (3) if the growth has extended into the naso-pharynx, this region will not be well exposed; (4) very disfiguring scars are left, especially objectionable in the case of a female patient.

Two semilunar incisions (1 and 2, Fig. 161), with their convexities downwards, are made across the facial aspect of the upper jaw, the lower running from the ala of the nose to the middle of the malar bone, the second starting from the nasal process of the frontal and passing just below the orbit to meet the first, where this ended.

* This section should pass above the roots of the teeth and well below the infraorbital foramen.

† Dr. Sands appends to his paper a photograph of the patient on whom he had operated by this method, after failing to remove the fibroma by the plan of M. Nélaton. The deformity is very slight, the malar prominence and the fullness of the cheek being well preserved.

‡ *Deutsche Klin.*, 1861, p. 281; and Schmidt's *Jahrb.*, Bd. cxiii. p. 198.

If needful, owing to the extension of growths backwards, the meeting of these incisions may be carried back along the zygoma (*b*, Fig. 162). Each cut is made down to the bone but the skin is not reflected. To avoid needless loss of blood, the lower skin incision and section of bone are made first, and then the upper division of skin and bone. At the outer end of the lower one the masseter is detached from the zygoma, and if the growth has extended out into the zygomatic fossa it will now come into view on dividing the buccal fascia. Prof. Langenbeck found at this stage that by pressing the growth to one side and depressing the lower jaw he could pass his finger through the pterygo-maxillary fissure into the spheno-maxillary fossa, and so on through the spheno-palatine foramen into the nose, all these parts being enlarged by the pressure of the growth. By means of a narrow straight saw introduced the same way the upper jaw was cut through horizontally (*a*, Fig. 162) from behind forwards, while a forefinger passed by the mouth kept the tip of the saw from striking against the septum nasi. (If the right upper jaw is operated on, the surgeon will saw outwards from the nose.) The saw was now applied along the

FIG. 161.



V. Langenbeck's osteoplastic and temporary resection of the upper jaw. The skin incisions are shown meeting on the zygoma.

(Esmarch and Kowalzig.)

FIG. 162.



The same operation. The lines for the saw through the zygoma and upper jaw.

(Esmarch and Kowalzig.)

upper incision so as to divide the zygoma (*b*, Fig. 162), the frontal process of the malar, and the upper jaw (*c*, Fig. 162), just below the lachrymal sac, up to the inner end of the incision. The portion of the upper jaw thus marked out now only remained attached, at its inner part, to the nasal bone and nasal process of the frontal. Upon these connections, as upon a hinge, the piece of bone was slowly raised by means of an elevator introduced under the malar bone, upwards and inwards, until the malar bone was nearly in the middle of the face. The growth was now completely exposed. The operation took an hour, and was attended with much hæmorrhage, most of which stopped spontaneously. The wounds healed well, a tendency of the bone to rise being met by pressure.

At the present time any surgeon making use of the above operation would wire the bone when fitted down. I would suggest, too, that the incisions through the bones might perhaps be more easily made with an osteotome and mallet, especially in cases where, the deep parts at the back of the jaw not being so much dilated as in Prof. Langenbeck's case, it is difficult to manipulate a saw and to cut from behind forward.

Prof. Langenbeck's patient was a lad of 15. The growth could be felt by the finger in the mouth, filling up the posterior nares on the left side, passing out between the masseter and maxilla; and on this side, too, the zygoma appeared more prominent, and the temporal fossa more full.

An interesting account of temporary resection of the upper jaw f-

naso-pharyngeal growth is given by Mr. Stanley Boyd (*Med. Soc. Trans.*, vol. xix., 1896, p. 391). Though the hæmorrhage was "not considerable," intense collapse followed, and lasted two hours. The patient made a good recovery.

The Choice of an Operation for Removal of Naso-pharyngeal Fibroma.—The relative values of several of the above operations have already been briefly given. The surgeon will have to weigh duly the following: On the one hand, the desire to get the growth away with as little mutilation and danger to his patient as possible, and, on the other, the fact that these growths are most certainly malignant in nature, and that any partial operation, while probably as difficult and as bloody as one on a larger scale, will, if incomplete, be certain to lead to increased growth in the tumour by the irritation which it causes.

Whatever operation is chosen, it will usually be wise, in order to diminish the risk of hæmorrhage, to perform a preliminary laryngotomy (pp. 614, 624), and to plug the fauces with an aseptic sponge. The laryngotomy tube should usually be removed immediately after the operation. Destruction of the root of the fibroma is best effected by a powerful curette, or a gouge, aided by strong formalin, not by the cautery if possible. The use of the latter is risky owing to the vicinity of the larynx, and the possibility of infective broncho-pneumonia from charred tissues. The risk of reappearance is great if the root be not completely destroyed. Iodoform may be used afterwards, aided by eucaine, by an insufflator passed behind the soft palate, or Whitehead's varnish (p. 605) may be applied at the time.

For naso-pharyngeal growths which come early under treatment, in which the growth is of moderate size, with an attachment situated well forward in the roof of the pharynx or within easy reach from the posterior nares, especially one which can be made out to occupy chiefly the region of the nose, such an operation as that of Lawrence may be made use of.

In cases of greater difficulty, from the longer duration, more extensive attachments, larger size, and, with this last, the certainty of a more extensive base and numerous large sinus-like vessels, the question of deformity and disfigurement must be entirely set aside.* In order to secure adequate space for making certain of all the attachments of the tumour, for eradicating these, and, at the same time, satisfactorily meeting the hæmorrhage which is usually inevitable, a freer removal of bone will be required. No doubt, for this purpose, partial or complete removal of the upper jaw should follow the preliminary attack by the nose. Every surgeon who has performed removal of the upper jaw knows how free is the access which it gives to the back of the nose and to the pharynx. A further advantage, pointed out by Dr. Sands, is the following, that, owing to the wide gap left by this operation, reappearance of the disease can be more readily recognised and treated than after any osteoplastic operation.

But while willingly admitting the great advantages which removal

* I may again remind the reader that these naso-pharyngeal polypi usually occur in males, often in lads or young adults. The growth of hair which can usually be secured in these cases lessens, to a considerable degree, the amount of disfigurement which operations on a larger scale entail.

of the upper jaw gives for free exposure of the growth, I cannot quite agree with Dr. Sands, who recommends this step on the ground that "excisions of the upper jaw are, as a class, remarkably successful operations." On the contrary, I should look upon this as a distinctly serious and grave operation (p. 489), especially in patients who, though young, often come before the surgeon with strength reduced by hæmorrhages, dysphagia, dyspnœa (especially when this is accompanied by attacks of choking interfering with sleep), infection, &c.

Dangers and Drawbacks of Osteoplastic and other Operations for Naso-pharyngeal Fibroma.—Many of these have been already given under the head of Removal of the Upper Jaw (p. 488); others, more particularly to be expected here, are:

1. Hæmorrhage, not from large arteries, as the internal maxillary, but from the fact that the very numerous vessels of the growth are embedded in close fibrous tissue and thus cannot retract, and that many of the veins are large and sinus-like. To meet this inevitable risk a preliminary laryngotomy should be performed, and the fauces plugged with sponge (pp. 614, 624). Hæmorrhage from the base of the growth, if persistent, must be arrested by adrenalin chloride, strong formalin, or plugging.

2. Meningitis, from damage to the base of the skull (p. 492), or from inflammation spreading to the membranes of the brain. Mr. Stonham (*loc. supra cit.*, p. 78) states that "it is a common experience that after removal of these polypi the patient suffers from intense headache, principally referred to the occipital region, but it usually passes off in a few days."

3. Necrosis and exfoliation.

4. Non-union of a temporarily resected fragment.

5. Reappearance. The best protection against this risk is either electrolysis or adequate exposure of the growth, especially its base, and then complete destruction of this by a powerful curette or a gouge, aided by formalin.

OPERATIONS FOR SUPPURATION OF THE ANTRUM. RADICAL CURE.

Tapping the Antrum.—This operation is required for suppuration in the antrum, nearly always in adults, and most frequently after dental trouble. But while this is a common, and as regards treatment, the most successful cause, others in which the suppuration in the antrum is due to causes more remote, must be remembered. Amongst these are the different forms of nasal obstruction, mischief in other sinuses (p. 335), and, occasionally, a foreign body.

Tapping may be performed in either of the following ways:—
(i.) Through the alveolar process. (ii.) Through the facial aspect of the upper jaw, above the alveolar process.

(i.) *Through the Alveolar Process.*—This method has the following advantages: (α) It drains the cavity at the most dependent part. (β) By withdrawal of the tooth it often removes the cause of the trouble. (γ) It does not involve any cutting. The operation is a slight one and rapidly performed.

The disadvantage connected with this operation is, that the cure takes months, it may be one or two years, and it involves daily attention to the tube required.*

A tooth has usually to be first drawn, and, as long ago pointed out by Mr. Salter (*Syst. of Surg.*, vol. ii. p. 467), "the tooth whose fangs are most intimately connected with the antrum is the first permanent molar;† and its removal in a case of antral abscess is especially indicated from this circumstance, and from the frail and perishable nature of the tooth itself, which gives it less often than other teeth a long tenure of usefulness." This being done, the orifice made should be enlarged by pushing a trocar or, better, a drill or gimlet up through the alveolus. Whatever instruments are used should be of sufficient size to ensure a free orifice, and, in driving them up through the bone, care should be taken that, when they enter the antrum, they should not plunge against and perforate the orbital plate. The opening, when made, is best widened by a "rat's-tail file."

When the bone is much condensed, the instrument used in perforating will be held so tightly that the surgeon will need to withdraw it once or twice, and use a probe before he can make certain of having opened the antrum. The opening should be large enough to admit an ordinary lead-pencil, and should be kept midway between the two alveolar plates.‡

The chief points in the *after-treatment* are to keep the opening * patent, to prevent the entrance of food, and to encourage a healthy condition of the lining membrane.

To ensure these ends, a short drainage tube is worn at first with its upper end just entering the antrum, and this cavity well washed out with boracic acid lotion. As soon as the parts are sufficiently consolidated a short metal tube and plate are fitted by a dentist. Through this the patient easily syringes out the cavity, at first three times a day, with lotions of boracic or carbolic acid, boiled saline solution, tincture of iodine or potassium permanganate—the lotion itself not being of so much importance as the regularity with which it is used.

* The patient should be warned at the commencement how very tedious these cases are, and told of the need of persevering and patiently prolonged treatment.

† Any other tooth, as Mr. Salter advises, molar, bicuspid, or canine, whose disease is possibly the cause of the abscess, will, of course, be extracted, as absorption round any carious tooth facilitates perforation of the alveolus. Where the first molar is healthy the antrum should be reached through the socket of the second molar or either of the bicuspids. Dr. Lack gives the following directions (Cheyne and Burghard's *Manual of Surgical Treatment*, pt. v. p. 341): "If the site of the first molar be selected, the drill should be inserted into the inner root socket and pushed in an upward and slightly inward direction towards the inner canthus of the corresponding eye. If the second molar or the bicuspids be selected the drill should in addition be inclined slightly forward or backwards respectively. In the case of the bicuspids especially great care must be taken to keep the drill in the exact direction aimed at, as the floor of the antrum anteriorly is often very narrow and may be easily missed. Care must be exercised to prevent the drill slipping when the teeth have been long removed, as the alveolar border tends to become dense and very narrow. The antrum may be missed in the few very rare cases in which it is very small."

‡ In many cases the operation is so simple that nitrous oxide anaesthesia, with eucaïne, suffices. But in his earlier cases I advise the surgeon to employ ether, and this will be needful when other steps have to be taken, such as the extraction of carious teeth.

After a time, when the discharge is no longer offensive and no inspissated, putty-like stuff comes away, some such astringent as silver nitrate (gr. 1—3j.) may be employed. When, after many months usually (*vide supra*), no discharge has been noticed for a few days, the irrigation may be stopped and the tube removed. If the closure of the opening is still tardy, this may be hastened, if no discharge is seen, by the application of caustics.

(ii.) *Supra-alveolar Route*.—In those cases where any offending tooth has been long extracted, where the alveolar process is largely absorbed, or its remains condensed; in cases where from their duration the interior of the antrum is much diseased, where polypoid granulations or caries are present, a freer opening into and examination of the state of the cavity are required, and the simplest way to secure these is to evert the cheek, incise the mucous membrane transversely, and thus expose the bone above the canine fossa. With a gouge or chisel the antrum is next opened, and the opening freely enlarged with burrs, &c. The interior of the antrum is then investigated with the little finger, discharge well washed out with boiled water, any polypoid granulations removed or carious patches felt with a probe thoroughly curetted. But, as in the case of the frontal sinus (p. 333), still more here, owing to the size of the cavity, the object of the surgeon must be to leave the lining membrane in as healthy a condition as possible, not to remove it entirely. According to the state of things found, the cavity is washed out with peroxide of hydrogen, or swabbed with pure carbolic acid or solution of formalin (1 in 250) or, one of zinc chloride (gr. xx.—3j.) and carefully plugged with a strip of sterilised gauze, one end of which is brought out at the opening in the bone. Repetition of this plugging is, from the nature of the parts concerned, so painful that it should not be made use of, a large indiarubber plug being inserted to keep the opening patent when the gauze is removed at the end of twenty-four or thirty-six hours. The patient removes this plug, three times a day at first, in order to irrigate the cavity.

While this method allows of a fairly free opening being made and of investigation of the state of the interior of the antrum by an operation easily performed, it has the following disadvantages. It causes some cellulitis and swelling of the face. To meet this boracic acid fomentations should always be applied for the first few days. Drainage by this route is not so efficient as by the alveolar. For these reasons I advise my readers to place the matter before their patients. Where the alveolar route is declined owing to its tediousness, or where it has failed, the radical method given below is much to be preferred.

(iii.) *Supra-alveolar and Nasal Route*.—In cases where the suppuration is of long duration, where the interior of the antrum is the seat of polypi or caries, or where it acts as a reservoir for pus coming from other cavities, where a sinus is present on the face, and where the patient is likely to be remote from skilled surgical assistance, the above treatment will be insufficient. While the size of the antrum, its rigid walls, and the fact that its lining membrane, like that of the pleura, cannot produce sufficient granulation tissue for the obliteration of the cavity, are potent reasons why antral suppuration is so obstinate, there is another to which I desire to draw attention, and that is the presence of tubercle bacilli. In one case of mine, a young man at Guy's

Hospital, this was proved to be the cause about four years ago. Suspecting this possibility, I asked Mr. Goadby, who is well known as a bacteriologist, to investigate the discharge, and he proved the existence of tubercle bacilli. As the patient went as a clerk to New Zealand, after treatment, we lost sight of the case. I must leave it to others to decide how far the above is a frequent *vera causa* in obstinate antral suppuration.

The only way of obtaining permanent and free drainage is to establish an opening between the antral cavity and the inferior meatus sufficiently large and permanent to prevent accumulation of pus in the antrum. The best method is that described by Dr. Lack (*loc. supra cit.*). I have found it in two cases both speedy and efficient. It is easy to carry out and unattended with any external scar. The preliminary steps are those given at p. 503. By these the antrum is first opened above the alveolus and its cavity explored and dealt with. When this has been efficiently done, a large opening is broken into the inferior meatus from the antrum by a gouge and a burr. The whole of the septum between the antrum and the inferior meatus is then chipped away with bone forceps or chisel. After the completion of the operation the outer opening is allowed to close and all subsequent treatment is conducted from the nose. Dr. Lack does not consider a drainage-tube or packing necessary. I used the former in my cases for the first few days, bringing the end out above the alveolus. Owing to the tendency of the nasal opening to close this *must* be made a free one. The *after-treatment* consists in washing out the nose and, if necessary, the antral cavity with boracic acid lotion. In the latter case "a suitable syringe is easily improvised by attaching a Eustachian catheter to the end of a small ball nasal syringe, with or without an intermediate piece of tubing. The catheter is passed under the inferior turbinate into the antrum. By these means a cure is almost invariably obtained in the course of a few weeks, and even in cases in which the antrum acts as a reservoir of pus, the large opening will prevent its accumulation in the cavity." (Lack.)

The following opinions of well-known authorities on the *results of operative interference* will be useful to the general surgeon who often has to rely upon himself in deciding what course he should pursue. Dr. Lack writes of the alveolar and supra-alveolar routes (*Man. of Surg. Treat.*, Watson Cheyne, C.B., and Burghard, pt. v. p. 343): "In considering the question of a cure by these means it is safe to say, (1) that in cases of dental origin, recent or chronic, a large majority are cured; (2) that in recent cases of nasal origin a majority are cured; (3) that taking all cases together, about fifty per cent. are cured and every case is greatly relieved; (4) that the cure depends to a large extent upon the care with which the patient conducts the after-treatment. If pus reappears in the nose immediately after washing out the antrum, there are such strong probabilities of other cavities being involved that they should be at once explored and treated if found diseased."

Dr. H. Tilley (*Brit. Med. Journ.*, Aug. 30, 1902, p. 585) found as the result of alveolar drainage in 34 cases, that 16 were cured of their discharge in from two to eighteen months, 14 were so relieved of their symptoms that they preferred to continue wearing their tube lest, by its removal, discharge should recur and necessitate further treatment.

In all these uncured cases, except one, the headache had disappeared, the discharge had diminished almost to vanishing point, and the patients were perfectly comfortable. As an antral discharge is so quickly diminished by alveolar drainage and irrigation, Dr. Tilley considered that *as a rule* the patient should be given a chance of cure or great improvement by this, the simplest mode of treatment. The exceptions to the above rule have been given at p. 503.

REMOVAL OF THE LOWER JAW, PARTIAL OR COMPLETE.

Indications.—These are much the same as those already fully given for removal of the upper jaw (p. 476). Mr. Butlin (*Oper. Treat. of Malig. Dis.*, p. 137) has treated of these growths, and has pointed out that here important differences are observable between the central and subperiosteal sarcomata. Thus the central (most often myeloid) sarcomata grow slowly, the subperiosteal quickly; the former are encapsuled, and even when they make their way into the surrounding structures they do not show that tendency to infiltration which is so marked in the subperiosteal sarcomata. The central ones are rarely associated with affection of the lymphatic glands, or with secondary growths. The above opinion, while held in this country, does not agree with that of German surgeons. Thus Schlatter writes (*loc. supra. cit.*): "Sarcomata originating in the periosteum usually have a firm consistence, and pursue a benign course. Sarcomata proliferating from the marrow and causing swelling of the bone are soft tumours, and are amongst the most malignant of neoplasms."

The following operations will be considered:

- A. Partial removal of the lower jaw.
- B. Complete removal of one half of the lower jaw (Fig. 164).
- C. Complete removal of the jaws, upper or lower.

A. Partial Removal of the Lower Jaw.—This is frequently required in the case of epulis. The steps are the same as those given already at p. 476. The alveolar border should always be removed; in the case of a growth very far back around the lower molars it is quite justifiable to slit the cheek, especially if the growth is becoming doubtful in character, and thus requires thorough extirpation.

The above remarks still more hold good in the case of a growth about the gums, situated far back, in an older patient, and becoming epitheliomatous.

Cases are occasionally met with where, owing to an epithelioma of the lip not having been treated, or to its recurrence, the symphysis of the jaw is infiltrated and requires removal. The soft parts being reflected by incisions, starting on either side widely of the diseased parts, converging towards the hyoid bone, and the vessels secured, the bone is sawn through in two places,* well beyond the level where its

* Mr. Heath (*Dict. of Surg.*, vol. i. p. 839) gives the following practical hint with reference to dividing the jaw in two places:—"In making these sections it is better not to complete one before the other is begun, because of the loss of resistance consequent upon breaking the continuity of the bone, but each cut, being carried nearly through the bone with the saw, may be conveniently finished with the bone-forceps."

softened, spongy state, and the loosened teeth show that it is invaded. The sawn surface left must be carefully scrutinised. The tongue, prevented from falling back by a loop of silk passed through its tip, is now detached by snipping through the mucous membrane, and the muscles attached to the genial tubercles. Any further hæmorrhage being looked to, the sub-lingual and sub-maxillary glands are examined, and, together with any enlarged lymphatic glands, removed if needful; flaps are dissected up from the neck to make a new lip (p. 536, Fig. 194); and drainage provided, the tubes being brought out below at the lowest level of the region from which the flaps have been dissected up. The adjustment of these to form the new lip will be the more easy in proportion to the amount of bone removed.

So, too, occasionally in epithelioma of the angle of the jaw, primary, or secondary to that of the tongue, the surgeon may be led, in order to relieve his patient's condition, if he cannot cure him, to operate extensively here. Thus, after turning up a horseshoe-shaped flap, with the concavity upwards, and clearing the masseter off the jaw, this bone is divided above the angle, then through the horizontal ramus, and removed, together with the sub-maxillary, sub-lingual, and lymphatic glands, which will probably be enlarged, and also adherent. The hæmorrhage will be free, from the facial and lingual vessels, and veins communicating with the external jugular. Free drainage must be provided.

Removal of part of the horizontal ramus or of the angle may be called for in cases of new growths limited to these parts; and the surgeon may, especially in the case of women, ask how far it is worth while to try and remove these from the mouth, detaching the soft parts with a raspator, and sawing the bone in front and behind the growth, as in the case of an epulis, but the section here passing through the whole thickness of the jaw. Mr. Maunder on two occasions removed large portions of the bone in this way. The following remarks of Mr. Heath (*Dict. of Surg.*, vol. i. p. 837) should be carefully considered before the surgeon, for the sake of avoiding a scar which will be but little noticed, undertakes a much more difficult operation, and one which, owing to the limited space it gives, may tend to his working dangerously near the growth: "The principal difficulty in these operations was not so much the separation of the tumour, as its 'delivery' through the mouth, which was slightly split in one instance. Fortunately the hæmorrhage in both cases was slight, and the patients did well; but another surgeon was less fortunate, and lost his patient by secondary hæmorrhage, but considering the close proximity of the facial artery, and the necessary division of the inferior dental artery, this is not to be wondered at. It may be doubted if the extra trouble and risk of the proceeding are balanced by the absence of a scar, which, in the majority of cases, need not involve the lip, and, if properly placed, will be nearly invisible afterwards."

Question of Removing a Portion or the Whole of One Lower Jaw.

—This matter will have to be decided when the surgeon, having a case of growth before him which involves the horizontal ramus as far back as the angle, is in doubt whether to saw through the vertical ramus or to disarticulate. In the great majority of cases, especially where the patient is no longer young, where the growth is not a central one, where

it has been attacked before, the operator had much best place his patient and himself on the safe side and disarticulate. The lower jaw being "a floating bone," this radical step often gives a better prognosis for operation here than in the case of the upper jaw. On the other hand, the lower jaw is so embedded in soft parts, and so near to important parts—*e.g.*, pharynx and pterygoid fossæ—that delay may render the extirpation of the growth impossible. I would refer my readers to two cases in which, after partial operations in Mr. Heath's hands (Hunt. Lects., *Brit. Med. Journ.*, June 18 and July 2, 1887), fatal extension and reappearance of the growth took place.

B. Removal of Half of the Lower Jaw (Fig. 164).—The patient's head and shoulders are raised, his body brought to the edge of the table, and the head moved to the opposite side. The operator stands on the affected side, or operates on either jaw from the right. The parts are again rendered as sterile as possible. A preliminary laryngotomy will rarely be called for, and only when the growth is so vascular as to make plugging of the fauces a wise precaution. As it will be well in most cases to explore the sub-maxillary region, the incision which

FIG. 163.



Gant's saw. A form very convenient for section of the jaws.
(Down Bros.' Cat.)

begins just below the lip* in the centre of the chin, should pass down to the hyoid bone. Hence it is carried laterally well below the mandible along the sub-maxillary cervical crease (Kocher) to a point a finger's-breadth behind and below the angle. The authority just mentioned advocates this level for the lateral part of the incision as sparing the supra-maxillary branch of the facial nerve. The incision is carried down to the bone over the chin; over the facial artery it should be only skin-deep. This vessel is next secured between two ligatures. In raising the flap thus marked out, the muscles, where it is safe to do so, are raised with it by a periosteal elevator and the point of the knife, including the small ones in front and the masseter and buccinator behind. Where there is any risk of their being infiltrated the flap must consist of skin and fascia only. Such arteries as the mental and masseteric will now probably need attention. From the inner aspect of the mandible the muscles are next detached—*viz.*, anteriorly the digastric, mylohyoid, genio-hyoid and genio-hyoglossus, and posteriorly the internal pterygoid, until the mucous membrane is reached, but the cavity of the mouth should not be opened at this stage, if possible. The flap that has been raised is wrapped in sterile gauze.

An incisor being extracted if needful, the jaw is divided to one side of the symphysis well in front of the growth, by means of deeply

* If there are reasons for especial speed, such as the condition of the patient, or if the growth is very large, the red border should be divided, as this facilitates matters much, and the additional deformity is very slight.

notching it with the saw* before using the bone-forceps or chisel. If it be needful to remove the bone so freely that the symphysis and the genial tubercles are removed also, the tongue must be carefully prevented from falling back upon the larynx by means of a loop of stout silk passed through the tip. The bone being divided and pulled outwards, any of the muscles which remain undivided on the inner aspect of the jaw, together with the buccal mucous membrane at its junction with the alveolus, are divided with blunt-pointed scissors. Care must be again taken not to leave behind any infiltrated tissues. In a very few cases, where the nature of the growth admits of it, the sub-maxillary and sub-lingual glands may be spared by keeping the knife or scissors close to the bone.

The anterior half of the jaw being now freed, the surgeon, taking it in his left hand, everts it so as to divide the internal pterygoid more freely, and also the inferior dental nerve and vessels. The jaw is next strongly depressed so as to bring down the coronoid process, and the

FIG. 164.



insertion of the temporal muscle. This strong tendon requires complete division, as depression of the bone brings fasciculus after fasciculus into view. If the coronoid process is very long it may hitch against the malar bone or be jammed against it by the bulk of the tumour: in such case it had better be cut off with bone-forceps, and, after the removal of the growth, dragged down with sequester-forceps and removed. After the temporal tendon is thoroughly detached (when this is effected the jaw comes down more easily), strong depression of the jaw is continued so as to

bring the condyle within reach, no eversion or rotation outwards of the bone being permissible at this stage of the operation, or the internal maxillary artery, which passes between the neck of the jaw and the internal lateral ligament, will be brought into the wound, and very likely cut, causing troublesome hæmorrhage. The external pterygoid is next partly torn through with the finger or the director, the capsular ligament is opened in front with the careful use of knife or scissors, which next, kept close to the bone, divides the lateral ligaments, when the jaw comes away, the final separation being usually effected by the remaining fibres of the external pterygoid being torn through, together with the stylo-maxillary ligament and the periosteum to which it is attached. The knife, if it is required here, should be kept very closely in contact with the posterior border of the ascending ramus. But usually, after division of the external lateral ligament, the mandible can be pulled away.

* When the condition of things admits of it, the jaw should always be divided as far from the symphysis as possible, in order to preserve the anterior belly of the digastric and its insertion, which will thus counteract the tendency of the muscles on the opposite side to draw the chin somewhat over. It is convenient to be provided with a Gant's saw (Fig. 163), or one with a movable back.

If the internal maxillary artery has been divided, which is sometimes excusable in cases of large growths extending far up, it can be readily secured in the large wound.

If the operator finds the vertical part of his incision insufficient, and yet does not like to prolong it for fear of damaging the chief part of the seventh nerve, the soft parts should be well raised by a retractor, after being pushed upwards with a periosteal elevator.

In cases where the jaw has been extensively thinned or eroded by growth it is very likely to fracture under the depression which is required to bring down the condyle. If this accident occur, removal of the condyle and coronoid process is rendered difficult, as the latter is drawn upwards under the zygoma by the temporal muscle. Their removal will be facilitated by dragging them down with lion-forceps and detaching the temporal tendon with blunt-pointed scissors. Formalin or zinc chloride (gr. 40—3i.) should be applied to a possibly infected surface.

All hæmorrhage being securely arrested, the sub-maxillary region is investigated, and if needful is thoroughly cleared out. Careful search is made for any remaining infiltration of the parts severed, or for any outlying portions of growth. The flap is then brought down, and adjusted with one or two points of silver suture and sutures of salmon-gut and horsehair, drainage being first provided for by bringing a drainage-tube from the neighbourhood of the condyle through the wound below. Iodoform with collodion is then brushed over the wound.

Especial care must be taken in exactly uniting the red line of the lip and suturing the mucous membrane with horsehair left long (p. 486) if this has been divided.

The wound is then dressed, as at p. 486, and the patient here also should be propped up to facilitate escape of the discharges. For the first few days it may be well to feed by a nasal tube, aided by rectal enemata and suppositories. The patient should wash his mouth out as frequently as possible, as directed at p. 487. The drainage-tube should be shortened so that, as soon as is safe, it ceases to communicate with the cavity of the mouth.

From time to time attention has been drawn to the need of replacing, artificially, the removed portion of the jaw (McBurney, *Annals of Surgery*, July, 1894, Pearce Gould, *Lancet*, Jan. 16, 1897, p. 179), and thus restoring, in a measure, the power of mastication and removing the deformity. C. Martin, a surgeon-dentist of Lyons, brought forward an artificial jaw made of gutta-percha in 1889. It is fastened to the remaining portions of the jaw with nails or screws at the close of the operation. A series of perforations allow of the passage of discharges and of irrigating fluids. It remains in place during the entire period of wound repair. About the third week it is replaced by a permanent artificial jaw provided with teeth. This and other forms of artificial jaws, some made of aluminium, are figured by Schlatter (*loc. supra cit.*). An admirable result of what Martin's splint can effect is shown by the illustration of a girl æt. 18, in whom, eight years before, Schlatter resected 10 cm. of the lower jaw. Here neither speech nor mastication were impaired.

Difficulties and Possible Mistakes during the Operation.

- (1) Slipping back of the tongue, if the symphysis has been removed.
- (2) Wound of the pharynx by not keeping the knife close to the bone

in separating the soft parts from the angle of the jaw. This interferes with the patient's being able to swallow from the very first. (3) Fracture of the jaw. (4) Jamming of the coronoid process. (5) Rigidity and permanent contraction of the temporal, masseter, &c. (6) Wound of the internal maxillary vessels. (7) Outlying growth in the temporal region, or near to the tonsil and large vessels.

C. Operations for Complete Removal of Both Jaws.*

Before leaving the subject of removal of the jaws, a few words may be said of those rare cases which occasionally call for removal of both the upper, or the whole of the lower jaw, or both the jaws on the one side.† Space does not admit of my doing more than give brief references to a few cases.

The growths which call for removal of both upper jaws simultaneously fall mainly under the two heads—(a) Epithelioma of the palate and alveoli involving one or both of the antra;‡ (β) Growths, usually sarcomatous, springing often from the base of the skull or some part of the naso-pharynx, and projecting forwards the jaws with hideous deformity.§ These cases are much less favourable than the epitheliomata.

In either case the parts are exposed by slitting the centre of the upper lip and then carrying the incision round the nose on either side, Fergusson's incision being made use of as far as needful. In a few cases, in order to get adequate room, it may be needful to make incisions from the angles of the mouth to the malar bones, and raise all the intermediate soft parts as a flap. Wherever it is feasible, as in cases where the growth has begun in the alveolar processes, the infra-orbital plates should be retained. This may be done by sawing through both bones from the nose outwards, and completing the separation of the lower part of the maxillæ from the upper by an osteotome or chisel. After the full account already given of removal of the upper jaw, no description need be given of these operations for removal of both halves simultaneously. The greater risk of shock, the liability to more profuse hæmorrhage, the probability of finding the growth extending far back into the different fossæ and along the base of the skull, are obvious. Later on, if the patient make a good recovery, the help of a dentist will be much needed in fitting some form of obturator, as articulation is now far more imperfect. The deformity is also obviously far greater. In fact the operation is only justifiable in a patient of good vitality and with increasing pain from pressure on the nerve foramina.

That such extensive operations are still, occasionally, required is shown by a case of Dr. Bernays, of St. Louis (*Med. Rec.*, Mar. 28, 1896). Here, in

* It is not always easy to tell the limits of a growth of the jaw. Thus one of these may extend up to the level of the lower part of the ear, bulge forwards close up to the nose, creep low down in the neck, and yet originate in the lower jaw. In deciding to which jaw a growth belongs, attention should be paid to involvement of the floor or roof of the mouth, and the results of masticatory movements.

† Mr. Spanton (*Brit. Med. Journ.*, 1885, vol. ii. p. 64) records a case in which first the upper, and, a few months later, the lower jaw on the right side became the seat of malignant disease. The jaws were removed at an interval of a week. The patient, aged 55, recovered from the operations, but the lower growth quickly reappeared.

‡ Godlee, *Clin. Soc. Trans.*, vol. xx. p. 260.

§ J. Lane, *Lancet*, Jan. 25, 1862; Dobson, *Brit. Med. Journ.*, Oct. 11, 1873.

a man, æt. 31, a recurrent sarcoma required the removal of both maxillæ and most of the bones of the nose. A preliminary tracheotomy was performed and Trendelenberg's apparatus employed. The patient made a good recovery, but the disease reappeared ten months later. Excellent photographs illustrate the condition before and after the operation. In two other cases Dr. Bernays had removed both maxillæ.

OPERATIONS TO RELIEVE FIXITY OF THE LOWER JAW

(Fig. 165).

SUTURE OF DISPLACED FIBRO-CARTILAGE.

The above condition may be due either to changes in the temporo-maxillary articulation resulting in ankylosis, or to cicatricial bands between the jaws, or to both.

Operations.—The two usually performed are :

(i.) Excision of the condyle, an operation indicated when the mischief is limited to the joint itself.

(ii.) Esmarch's operation of removing a wedge of bone from the horizontal ramus in front of the cicatrices and masseter; this operation being preferable to the first when scars are present which interfere with excision of the condyle.

Conditions justifying One of the above Operations.—Inability to open the mouth, resisting use of wedges, &c.* Fætor of saliva and breath. Difficulty of speech. Inability to eat solid food. The above are brought about by the following causes, which will be enumerated together here, though some call for one of the above operations and some for the other, viz. :

1. Inflammation of the joint set up by a punctured wound,† gonorrhœal arthritis, severe contusion‡ or sprain, osteo-arthritis,§ or suppurative arthritis, from abscesses burrowing into the joint, *e.g.*, abscesses connected with otitis media. 2. An unreduced dislocation in which much stiffness remains after attempts at reduction have failed, in a patient healthy and not advanced in life. 3. Cicatrices after sloughing set up by scarlet fever, measles, typhus, cancrum oris, or mercurial stomatitis. 4. Cicatrices after suppuration due to necrosis or alveolar abscess.

The most difficult cases to deal with are those where there has been much previous suppuration, and where the mischief is bilateral. The

* Mechanical apparatus must be used early to do any good. Daily forcible use of levers is usually unsatisfactory, and the use of interdental shields can do little more than retard scar-formation.

† Cf. Mr. Hilton's case (*Rest and Pain*, p. 114), in which bony ankylosis of this joint and of the upper cervical vertebræ seemed to date to a punctured wound in the neck.

‡ Mr. Heath (*R.C.S. Lects.*, 1887, vol. ii. p. 114), mentions a case in which ankylosis of the temporo-maxillary joint followed on a kick from a horse on the side of the face. In such cases a fracture may co-exist. W. J. Roe (*Ann. Surg.*, May, 1903) is of opinion that bony ankylosis here invariably results from fracture.

§ Good illustrations of this condition are given by Mr. Heath (*Brit. Med. Journ.*, 1887, vol. ii. p. 55). The fibro- and articular cartilages will probably be wanting. See also Prof. Humphry's case, *A Report of Some Cases of Operation*, pamph., 1856.

earlier any needed operation is performed in young patients the better, owing to the interference with the eruption of the teeth, and the wasting of the muscles which is sure to follow. In my experience the best results follow on bilateral excision of the condyle, with removal of the coronoid process if needful. It has been stated (R. Matas, *Journ. Amer. Med. Assoc.*, Nov. 28, 1903) that if Esmarch's method be made use of on both sides, loss of control of the intervening fragments will follow. Mr. Swain's case (p. 514) proves that this is not correct. In the worst cases, several operations and the most persevering after-treatment will be required, if a satisfactory result is to follow.

Excision of the Condyle (Fig. 165).—This operation is indicated when the mischief is limited to the joint itself, as may be the case in the first two conditions given above.

It may be performed as follows:

An incision about $1\frac{1}{2}$ inch long is made on a level with the tragus along the lower border of the zygoma. The parotid and branches of the

FIG. 165.



A, Excision of condyle. B, Excision of coronoid and condyloid process. C, Esmarch's modified operation. This must always be in front of all cicatrix-tissue. It happens to correspond here to an edentulous part of the jaw.

facial nerve being drawn down, the masseter fibres are cleared away from their insertion with a narrow elevator, and the joint exposed. The neck of the condyle is now sawn through with a fine saw, or divided with an osteotome, and the condyle turned out with an elevator, the external pterygoid being detached. The fibro-cartilage is left behind. The periosteum should not be preserved. The bone, which must not be splintered, should then be further pared down; and the operation will very likely need repeating on the opposite side before sufficiently free movement is regained. Care must be taken in prising out the condyle, in the use of gouges, &c., not to open the cranial cavity. The use of a small drain, *e.g.* of sterilised horsehair, will, usually, be advisable. While the patient is still under the anæsthetic the mouth should be opened with a gag to a full inch at least, more if possible. The use of hard wood wedges or cones grooved transversely to give resting places for the teeth should be methodically employed. This step should be frequently repeated with the aid of nitrous oxide or ether if needful. The case must be watched most carefully owing to the frequency with which relapses take place.

If more room is required a small triangular flap is raised and turned forwards by a short incision following the lower margin of the zygoma and a second similar one descending from this over the joint, and placed anterior to the temporal artery. Injury to the facial nerve, the parotid gland and duct, and the transverse facial artery is avoided by careful dissection with blunt instruments.

In severer cases it will be advisable to remove the coronoid process as well, and thus leave a wider gap. Dr. Mears (*Amer. Journ. Med. Sci.*, 1883, p. 459) considers that this method has the advantages of being applicable to all cases, and of giving better results, and I entirely agree with him from my experience of it in one case in which the result was excellent. A little facial paralysis, usually temporary, is often present after removal of the condyle. After more extensive interference with the soft parts, there is a greater risk of its being permanent. After operations here, liable to be followed by much swelling, the best dressing will be a hot boracic-acid fomentation frequently renewed. To prevent recurrence of the stiffness, every means should be taken to ensure asepsis of the wound throughout. If hæmorrhage occur, plugging with sterilised gauze must be made use of.

A word of caution is needed here. In one of Roe's cases (*loc. supra cit.*) asphyxia, due to the falling back of the hyoid bone and tongue, followed on opening the jaw. Roe saved his patient by laryngotomy.

Esmarch's Operation (Fig. 165). This operation, which is suited to those cases where the fixity is brought about by cicatrices within the mouth rather than by mischief limited to the joint, consisted at first in simple division of the mandible. Removal of a wedge-like piece of bone, in other words, a cuneiform osteotomy, in front of all scars, is to be preferred. Division of the bands inside the mouth is absolutely futile, and attempts to cover the wounds, made by excision of scars, with flaps of mucous membrane or skin are difficult, bloody, and disappointing. The most recent of these is the plan of the late v. Mikulicz, who drew forward a flap from the masseter, and fixed it to the edges of the gap between the fragments with sutures.

An incision 2 or 2½ inches long is made along the lower border of the jaw in front of the masseter and cicatrices. This incision should go down to the bone: the facial artery will probably need securing. As the soft parts are raised, any muscular fibres met with on either aspect should be carefully detached. A triangular wedge of bone, of sufficient size, is then removed with a narrow saw, *e.g.*, Gigli's (p. 369) or Gant's (Fig. 163). The sections should be made as cleanly as possible to avoid risk of necrosis, and the periosteum should be removed with the bone. The wedge should measure at the very least 1½ inch below and ¾ inch above,* and it must be taken from a part entirely in front of any cicatricial tissue.

If possible, its apex should correspond to an edentulous gap in the alveolar process. If the dental artery bleed freely, the foramen should be plugged with a tiny sterilised wooden plug or the bone crushed in around the bleeding point.

Some surgeons, who prefer a cuneiform osteotomy to excision of the condyle, advise removal of the bone at the angle of the jaw, not in

* In two of Mr. Heath's cases the wedge removed included the mental foramen.

front of it. Here an angular skin incision is made. Such a course would only be permissible where no cicatricial tissue is present. To prevent a return of the ankylosis some Continental surgeons have inserted a flap of muscle, *e.g.*, temporal in the case of the condyle, and masseter in that of Esmarch's operation, securing it in place with sterilised catgut. We owe this step to the ingenuity of French surgeons, who first made use of it by inserting a flap from the triceps after excision of the elbow. I believe it to be a needless complication if only sufficient bone is removed in every case.

Owing to the tendency to relapse,* passive and active movement should be made use of early, and at first, if needful, with the aid of an anæsthetic.

The operation should be performed early in cases where cicatrization after severe ulceration is leading to increasing fixity of the jaw, ultimately needing operative interference.

That well-known surgeon Mr. Swain, of Plymouth, who advocated Esmarch's operation strongly, as preferable to the operation on the condyle, published a most successful case (*Lancet*, vol. ii. 1894, p. 189), in which he operated on both sides simultaneously, by a modification of Esmarch's operation.

The jaws had been closed, after scarlet fever, for thirteen years. An excision about an inch and a half long was made just at the angle of one jaw, and then on the other side, parallel with the line of the jaws, the point of the angle being at the centre of the incision. The knife was carried at once down to the bone. With a raspator the whole of the periosteum on the outer and inner surface of the angle of the jaw was lifted from the bone, together with the insertions of the masseter and internal pterygoid. A narrow saw was then applied, and a triangular piece of bone removed, including the angle of the jaw, and measuring at its base about one inch.

Mr. Swain thus compares his modification of Esmarch's operation, with removal of the condyle: "From an anatomical point of view there can be no doubt that the operation is a far simpler one. The incision is so placed behind the angle of the jaw as to be hardly perceptible. The careful raising of the periosteum from the bone not only renders the future steps of the operation almost bloodless, but affords great support to the central portion of the jaw, especially when, as in my case, both sides are operated upon simultaneously. The only really important parts divided are the inferior dental artery and nerve. From the artery there is little or no hæmorrhage, and should it occur it is easily controlled by plugging. The division of the nerve is absolutely of no importance, the only result being slight anæsthesia over the chin. The division of the bone at the angle sets free the whole of the masticatory apparatus of the lower jaw, which can be at once opened to its full extent. The subperiosteal method preserves the attachment of the masseter and internal pterygoid to the inner surface of the angle, thus keeping intact the two elevator muscles. If

* This relapse is more likely if the wedge is not removed well in front of all cicatrices. Thus, Mr. Heath (*Dis. and Inj. of the Jaws*, p. 332) found, two years after Esmarch's operation for complete closure of the jaws, that the interval between the left molars had diminished from $\frac{3}{4}$ to $\frac{1}{2}$ inch, and that between the lateral incisors from $\frac{1}{2}$ to $\frac{1}{4}$ inch. Mr. Heath thought that in this case he had not been sufficiently careful to make the bone section entirely in front of the cicatrices.

a sufficiently large wedge is removed the danger of relapse is very remote." Mr. Swain collected in his paper nineteen other cases of operation for closure of the jaws, of which twelve were cases of removal of the condyle or portions of the neck. In very few of the former was the result comparable with that obtained by Mr. Swain in his case.

Suturing of a Displaced Inter-articular Fibro-cartilage.—Where subluxation of the cartilage does not yield, as it usually will, to blistering, tonics, &c., and troublesome clicking and catching of the jaw persist, Prof. Annandale has twice successfully operated as follows (*Lancet*, 1887, vol. i. p. 411): An incision about three-quarters of an inch long is made over the posterior margin of the external lateral ligament, and carried down to the capsule. Bleeding having been stopped, the capsule is opened, and the fibro-cartilage seized and drawn into position, then secured by catgut to the periosteum and other tissues at the outer margin of the joint.

CHAPTER VIII.

OPERATIONS ON THE LIPS.

HARE-LIP AND OTHER PLASTIC OPERATIONS ON THE LIPS.

HARE-LIP (Figs. 166 to 181).

IN the remarks that follow, and in all kindred instances, I wish it to be understood that I am writing only for my junior brethren, men who are at the commencement of their surgical experience, and whose surroundings in the difficulties which they have to face have to be carefully taken into account. The view held by some that the operation on the palate should *always* precede that on the lip and should *always* be performed very early in life is referred to at p. 549. Brophy's operation is described at p. 570. I need not remind the thoughtful amongst my readers that it does not in the least follow that the success attained by a few who have had especial experience and opportunities applies to, or that the rule laid down by them is to be safely followed by, others whose lot and whose surroundings are widely different.

Best Time for Operation.—Any time after the second or third month. For most cases the third to the sixth month is the best. All should be over by the seventh month, when dentition begins.

With regard to operations at an earlier or later date than the above, it is interesting to note what Sir W. Fergusson, whose experience was unrivalled, advocated with a riper experience. Thus in his *Practical Surgery* (4th ed. p. 573, 1857), he wrote: "I have myself operated very frequently within the first three weeks"; and a little later, "From all my reflections and experience on the question, I am more than ever disposed to recommend a very early operation." In his *Royal College of Surgeons Lectures on the Progress of Anatomy and Surgery* (1867), with an experience of between 300 and 400 cases, he wrote: "I decidedly prefer about the end of the first month." Writing later on (*Brit. Med. Journ.*, 1874, vol. i. p. 403), Sir William stated that his favourite time was from "three weeks to three months."

While the rule of British surgery is to get the operation over before dentition, many German surgeons defer taking any steps till the child has entered on the second year. Thus, Prof. Billroth* announced his practice as follows:—"Unless the parents urgently demand an operation as early as possible, I generally prefer to operate on children when they are more than one year old. I always advise this in strong children

* *Clin. Surg.*, Syd. Soc. transl., p. 78.

with complicated hare-lips, especially when the inter-maxillary bones are displaced and the hare-lip is double. I have been particularly satisfied with the results of operation, as far as appearance is concerned, on children at rather later periods of life and in adults." Some further remarks of Prof. Billroth are quoted at p. 528.

My reasons for deferring the operation, as a rule, till after the second month, are :

1. The difficulties of getting children with hare-lip to take sufficient food are exaggerated. Very often, unless the palate is cleft in addition, these children can suck well, and are in good condition. When the palate is also cleft, a serious difficulty may arise from the food passing into the nose, but this may be usually met by careful feeding with a small spoon put well back, if a sucking-bottle with a large teat and a good-sized hole in it fails (p. 548). This it will very rarely do, if slowly raised so as to give a little milk each time. Sometimes it is best to have the child raised when fed. The mother's milk should always be drawn and given when possible.

When the child really cannot get sufficient nourishment, and is marasmic from this cause only, the surgeon may, of course, operate before three, or even two, months. But a child that is daily wasting is, daily, less and less able to meet the strain entailed by the operation, and consequent repair. This should be clearly understood by the friends, and also the following fact :

2. It is not uncommon for children with hare-lip to die soon after birth from causes quite apart from this deformity—viz., diarrhœa, lung-trouble, exhaustion. In such, operation is unadvisable. It will not mend matters, and death will be put down to it, and not to the above causes, which would have destroyed the child in any case. In another, smaller, class of cases the operation itself, chiefly from the pain it causes in a weakly child, seems to start a process of fatal wasting.

3. As stated by Sir T. Smith (*Lancet*, 1867, vol. ii. p. 761), "The operation can be done much more perfectly and artistically on a young child than on a new-born infant, the parts being larger, more fleshy, and more easily handled." Sutures also cut out less readily.

4. For the first few weeks of life the child has scarcely got over the change from intra-uterine to extra-uterine life, the digestion is not yet, so to speak, in full swing, and a very slight shock may be too much for the low vitality of this period. Until those surgeons who operate on cleft palates during the first weeks of life publish a sufficient number of cases to prove the contrary, the above statement must remain in accordance with common surgical experience and common sense.

5. The objection that early closure of the hare-lip renders access to the cleft palate more difficult is dealt with at p. 550.

Condition of the Hare-lip.—Before operation, the following must be inquired into. Is the cleft single or double? If single, is it simple—i.e., without involving the nose, and without fissure of the palate? Are the sides equal and acute-angled, or divergent and unequal? Other sources of difficulty are, much flattening of the nose from the septum being adherent and dragged over to the superior maxilla on one side, and the ala of the opposite side being spread out and stretched over the upper part of the fissure. Or the edges of the lip are widely apart, and by no means to be approximated, the alæ being so widely separated that

lines let fall vertically through them only just come within the angles of the mouth.

Other more general points will, of course, be remembered as influencing the result of the operation. Amongst these are, the digestive and sleeping power of the infant; its family history; the existence of any weakening condition, such as otorrhœa; if it is in a children's hospital, the possible presence of any cases of infantile diarrhœa, and, by no means least, the good sense and patience of the nurse.

The **Single Hare-lip** operation and the one applicable to the largest number of cases will be first described fully, and then some other modifications.

(i.) **The Operation best adapted to the largest number of cases** (Fig. 166).—The child being wrapped in a towel, mummy-wise, to ensure the hands being secured if it "come to" prematurely, A.C.E. is given fully, and the head is held suitably presented to the operator by an assistant, whose hands, at the same time, make pressure upon the facial arteries as they cross the jaw. The lips, and, generally, the alæ also, are now freely separated from the subjacent bones to allow of their coming together without tension. During this step the knife should be kept very close to the bone, otherwise the hæmorrhage will be free. Some advise the use of a blunt instrument here after the mucous membrane has been incised. Unless this separation of lip and lower nose be thoroughly carried out, the tension on the sutures a little later will be certain to interfere with successful union. To render the separation efficient the knife must sometimes be carried quite up to the infra-orbital foramina, while the alæ nasi must also be thoroughly separated so that any flattening and distortion of the nostril may be rendered shapely. The bleeding is met by keeping the knife very close to the bones, and after the soft parts are freed, making gentle pressure.

If one pre-maxilla and maxillary bone project inconveniently beyond its fellow, it must now be forced back into place with the finger and thumb,* or with non-serrated forceps covered with thin drainage-tube. The bone should be felt to crack when this is done; otherwise, if merely bent back, it springs forward again and causes tension on the flaps.

If it is really necessary, as in an older patient, the anterior plate of the bone must be divided with strong scissors or a very fine saw. Whichever is used, care should be taken to apply it above the level of the tooth-sacs.

Dr. Rawdon (*Brit. Med. Journ.*, 1883, vol. ii. p. 724) advises that this bone should never be interfered with if the two halves of the lip can be brought together over the projection without tension, as (1) the curing of the hare-lip is sufficient to diminish the gap and depress the projection, and as (2) by interfering with it a low condition of septicæmia may be set up. Dr. Rawdon's advice should be carefully followed. The bone can almost always be forced into place, without any cutting, at the early age at which cases of hare-lip are usually operated upon. And the danger of septicæmia in a wound which cannot be kept aseptic is not a remote one in an infant of low vitality.

* If the back of the child's head is firmly supported, the thumb of the surgeon will, usually, quickly fracture back the bone into place.

The edges of the cleft are now pared. This, the most important part of the whole operation, must be done carefully, and thoroughly as well. The surgeon seizes the lower angle of each flap alternately, either with his left forefinger and thumb, or, if the parts are very small and slippery, with tenaculum-forceps, which should not hold the soft parts too near the edge, or they will tear out too soon. The edges being thus made tense, the surgeon with a narrow-bladed, thin-backed, small knife (scissors are on no account to be used) pares them as widely as possible by two incisions, beginning above at the upper angle of the cleft, curving outwards somewhat as they descend, quite clear of the edges of the fissure, and then, in the lower part, curving inwards again, through the red prolabium. Beginners nearly always make the mistake (Fig. 166) of removing only a thin paring of red surface. The pared surfaces should be made as wide as possible, especially below, in order that the

FIG. 166.



(After Whitson, *Edin. Med. Journ.*, 1883, p. 7.)

The dotted line shows the cleft widely and freely pared. The dark one shows timid paring close to the prolabium. The advantages of the first incision are—(1) A broader lip. (2) Firmer union, as a greater number of vascular points are cut which will throw loops across. (3) A better grasp for the sutures. (4) A more vertical depth to the lip, the two points, A, A, being on a lower level than B, B. The lower ends of the dotted lines should have been shown curved downwards and inwards in the usual way.

sutures may hold better and the lip be deeper. In Mr. Owen's words (*Cleft Palate and Hare-lip*, p. 96) the object is to carve out as massive pieces as possible, not little flaps. If one margin of the flap is longer than the other, this should be pared first, and after this its fellow, that both may correspond. The hæmorrhage from the coronary arteries is met by seizing them with small Spencer Wells's forceps, which serve to approximate the lips when the first and lowest stitch is inserted.

The assistant who steadies the head and keeps pressure on the facial arteries, now, with two fingers, presses the cheeks together, so as to bring the flaps into apposition while the surgeon introduces his sutures. I much prefer for these, first, two or three of stout well-boiled salmon-gut, the lower to command the coronary arteries, and passed close to the mucous membrane. If one flap is still shorter than the other, this stitch may be passed through the opposite side from below upwards, then entered on the shorter side at a point a little higher than that at which it left its fellow, and passed from above downwards so as to tilt down the margin which is the higher,

and bring it level with the other. This first stitch being passed, and the chief fear of bleeding removed, three or four others of gossamer gut

FIG. 167.



Single hare-lip, with wide cleft, the two sides widely divergent and not on the same level.

or horsehair* are inserted, one being placed in the free margin of the lip to keep the wound carefully closed here against the entrance of milk, saliva, &c. In adjusting the top stitch care must be taken that

FIG. 168.



The same case, three weeks after operation. The lip is broad and deep, and the red line level. The septum is still a little dragged down. The patient was a healthy country infant, with a devoted mother, sent me by Dr. Roland Cox, of Kintbury, Hungerford. Both this and Fig. 167 are from photographs taken at Guy's Hospital.

* Silk should not be used, from its tendency to become infected here.

it does not too much depress the tip of the nose, if the cleft has been one running up into the nostril. Another precaution to be taken with the nose is to see that the alæ are symmetrical and that neither nostril is left a mere chink. The occasional importance of this is shown by the case related at p. 522. All the chief stitches should be inserted with very fine needles, one-third of an inch from either side of the cleft. A few more hints may be given with regard to the sutures. They should be used freely, and, in addition to the lowest which commands the coronary arteries, two should be passed deeply enough to bring the whole thickness of the orbicularis together, and to control the vessels. In tying them there must be no strangling of the tissues; the tension required is to hold the cut surfaces together with allowance for some swelling. In tying them, if their ends be left a little long, their removal will be facilitated.

Hare-lip pins are never needed. They are useful, no doubt, in promoting close and accurate union where the parts come together easily, but at the expense of the risk of sloughing and scars even here; where tension is considerable, this risk is very much increased. The sutures already described, and the prevention of tension by free separation of the soft parts from the bone, will meet every need. If pins are used they should be far slenderer than those usually sold; the first should be inserted low down so as to command the coronary arteries, and, if one side of the cleft is shorter than its fellow, the pin should be passed so as to draw it down, in the manner already described. The pins must be removed at the end of forty-eight hours, or scar-points will be left. In feeble children the above time is too short for firm union to have taken place; and however carefully the pins are taken out, their removal must disturb the delicate adhesion more than the taking out of stitches.

The sutures being tied, the nostrils are cleared of any clots, some iodoform and collodion* are painted on evenly over the wound, and the following dressing applied:

A piece of iodoform or sal alembroth gauze two layers thick should be cut before, of appropriate size and of butterfly shape, so that one wing can be fixed upon each cheek, while the uniting portion, cut just the width and depth of the lip, passes over the wound. This dressing is secured in place with collodion, and, while it is being adjusted, an assistant holds the cheeks forwards, a position which must be maintained until the collodion is firm. For this most useful dressing, which keeps the parts together and protects them from saliva, &c., I am indebted to Mr. Rose (*Hare-lip and Cleft Palate*, p. 84). It is as efficient as it is simple.

In the after-treatment, the wound may be looked at on the second or third day, the stoutest salmon-gut or silver wire removed on the fourth day, and the others left in much longer. A sterilised camel's-hair brush is the best means of cleansing the wound. On each occasion the child must be firmly held, and the cheeks most carefully supported, while a similar dressing to that described above is applied.

One point of great importance is not alluded to in surgical works,

* The collodion will not only help to hold the parts together, but will prevent milk, saliva, &c., from getting between the flaps.

and that is, that in some cases of hare-lip death from dyspnœa may take place very soon after the operation. Thus, where the cleft has been a large one, and the upper lip when restored is tight, when it overhangs the lower, if the nostrils are flattened and partially closed by the operation, owing to the tension of the parts, so little breathing space may be left that temporary interference with respiration may occur, with grave and even fatal results before the breathing can be accommodated to the altered circumstances, and before the parts dilate and stretch.

The first case that drew my attention to this accident occurred in the early part of 1887, at Guy's Hospital. I had operated on an infant, aged three months, having a large cleft with unequal sides and going through the alveolar margin, the two halves of these being on different levels. The projecting alveolus was broken back into position, pared, and stitched with chromic catgut to its fellow. The edges of the cleft were then pared and united. They came together excellently, the wide cleft being replaced by a deep upper lip. One nostril was rather chink-like. About half an hour after, whilst I was engaged in another operation, a message came that the child was livid and dying. I had the child at once brought to me in the theatre; the dressing was removed, the tongue carefully drawn forward, and artificial respiration performed. The child quickly recovered and began to cry, though not very vigorously. Three-quarters of an hour later its breathing again failed, and, though Mr. Wachter, the senior house-surgeon, at once repeated the artificial respiration, he was unable to resuscitate the child. At the necropsy no clot was found in the fauces, nor anything wrong beyond the suddenly occluded oral passage.

I find that my old friend G. A. Wright,* of Manchester, has recorded two such cases:

The children here were aged three and five weeks respectively, the hare-lips double; in one, after the operation, the lower lip was drawn in so much as to leave but a small opening, but there was not apparently any dyspnœa. In one case dyspnœa came on suddenly, and, as no relief followed on pulling the tongue out, tracheotomy and artificial respiration were performed. The child recovered, but a few hours later the breathing failed again, and death ensued. In the second case, the child was found dead in the night. "The cause of death was probably valve-action of the lower lip."

Mr. Rose (*loc. supra cit.*, p. 85) draws attention to the need of the nurse depressing the lower lip frequently with the index finger, or by painting on a strip of collodion between the lip and the chin, until the child has become accustomed to the diminished oral aperture, otherwise the efforts to draw air through the closed mouth will tend to disturb the wounded surfaces.

In a few cases of hare-lip where the divergence is great, and where the sides of the cleft are very unequal, the following operations may be made use of, but it will be found that, on the whole, the first-mentioned is not only the quickest performed, but also gives the best results in the largest number of cases, as long as the flaps have been freely separated from the upper jaws and the edges broadly pared. Operations for hare-lip are not common enough to give every surgeon a

* *Abstracts of Cases treated at the Pendlebury Hospital*, 1885, p. 146. In his *Abstracts* for 1883, Mr. Wright records a case in which, after an operation for hare-lip, there was so much dyspnœa, from the tongue clinging to the roof of the mouth at each inspiration, "that it had to be pulled out and fastened by a ligature."

large individual experience in this special line. As the one that I have first described is that best adapted to the largest number of cases, I advise my younger readers to attain skill by practising it on every occasion.

(ii.) **Operation of Clémot* or Malgaigne** (Figs. 169, 170).—The edges are pared down to, but not beyond, the red lines; the flaps thus detached above are turned downwards and kept out of the cleft with a probe. The upper part of the cleft is then sewn

FIG. 169.



(Nélaton.)

FIG. 170.



(Nélaton.)

together with the sutures already advised, while the projecting point is shortened as required with a pair of sharp scissors and united with one or two points of horsehair. The chief objection to this method is, that, unless great care is taken, a little skin,

FIG. 171.†



(Nélaton.)

FIG. 172.



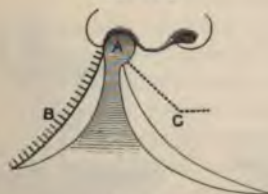
(Nélaton.)

imperceptible at first, but showing white after a time, may remain below the red line, or as a break in it. Again, the projection is very liable to get in the way during feeding.

Where the divergence is more marked, and the sides of the cleft very unequal, the following may be made use of.

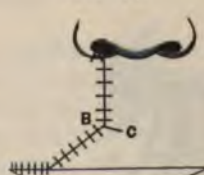
(iii.) **Method of Mirault** (Figs. 171, 172).—On the side which is the more vertical

FIG. 173.



(Owen.)

FIG. 174.



(Owen.)

of the two an incision is to be made downwards and outwards from the apex of the cleft to the junction of skin and mucous membrane, so as to leave a flap on this side free above, but attached below. The other, more sloping, side is then freely pared throughout its

* M. Nélaton (*Pathol. Chirurg.*, t. iv. p. 496) states that M. Malgaigne here imitated M. Clémot, of Rochfort.

† The sides, especially the one which is refreshed, should be pared as in Fig. 172—that is somewhat and not of the flaps, as it were by ii

it, should
nt of

extent from the apex downwards and outwards. All adhesions of the lips to the gums being then thoroughly separated, the flap is brought across and attached to the pared opposite side with the sutures already mentioned.

If this method be made use of, the flap must not be a mere paring, but cut as thick and succulent as possible, and the opposite side must be thoroughly and widely refreshed.

FIG. 175.



(Nélaton.)

FIG. 176.



(Nélaton.)

Figs. 173 and 174 show a modification of the above, introduced by Mr. E. Owen (*Lancet*, 1887, vol. ii, p. 361). The right side is first widely pared. To free the flap

FIG. 177.



a.



b.



c.

König's operation for single hare-lip. (Tillmanns.)

which is to be brought across from the left side, the incision is first made as usual from *a* to *c*, and then outwards. The object of this outward prolongation is to enable the flap to

FIG. 178.



a.



b.



c.

Hagedorn's operation for single hare-lip. (Tillmanns.)

lie level smoothly when it is brought over—*i.e.*, without kinking, to which there is otherwise a tendency.

(iv.) **Method of Nélaton** (Figs. 175, 176).—This gives another means of substituting a protuberance for the cleft. An incision resembling a *V* reversed is made around the upper angle of the cleft. By this means the red edge of the cleft is separated from the

two halves of the lip, except at each corner below. This red edge is next turned downwards, or reversed so that the Λ -shaped wound becomes diamond-shaped. The bleeding surfaces are then brought together by the means already given.

Mr. Holmes (*loc. infra cit.*) considers that Nélaton's operation is peculiarly adapted to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril. These instances are rare, but Mr. Holmes further points out that in cases where an unsightly notch is left behind, if there be not much cicatrisation around the incision, the deformity may be almost certainly remedied by this operation.

The operations of König and Hagedorn are explained by the figures which illustrate them.

Occasionally, after an operation for hare-lip, the new lip is too small and the lower one unduly prominent, conditions sometimes inseparable from operations upon wide clefts. If this deformity prove likely to be permanent, it may be remedied later on by taking a wedge from the lower lip and careful adjustment of the gap (Owen, *Surgical Diseases of Children*, 3rd edit. p. 227).

DOUBLE HARE-LIP (Figs. 179, 180, 181).

This is often easier of cure than single hare-lip with very divergent sides and the alveolar margin cleft and its two parts on unequal levels. For in double hare-lip the mischief is often symmetrical, and the sides less divergent.

Sir T. Smith (*loc. supra cit.*, p. 799) gives the three following varieties of hare-lip which are met with here and which are of practical importance:

- (a) When the pre-maxillary bone is *in situ*, and the two clefts are simple and fairly bilateral.
- (β) When the pre-maxillary bone is separated from the rest of the jaw and projects forwards, in some cases slightly, in others being attached to the vomer and hanging from the tip of the nose.
- (γ) When the pre-maxillary bone is small and ill-developed, and when the clefts are widely gaping.

The first two of these require notice.

(a) If the pre-maxillary bone is in proper position, the skin over it is freed from its attachments behind and pared to a point. The sides of the cleft are next pared from above downwards (as in Figs. 166, 179), and the parts brought together by transfixing the sides and the central flap with salmon-gut and silver wire sutures, every care being taken to keep the central piece well down. -Horsehair and gossamer salmon-gut sutures are also used as well. As the central piece is always shorter than the lip itself, the resulting wound is Y-shaped, and it is the side flaps which meet each other in the middle line below. Care must be taken to free the central flap right up to and with the tip of the nose, and not to depress the latter too much with the sutures, otherwise the nose will be flattened. As in single hare-lip, where one side is larger than its fellow, a flap may be freely cut from it to form the probabium and lower border of the new lip by the method shown in Fig. 171.

(β) Cases in which the pre-maxillary bone is separated from the

FIG. 179.



(Nélaton.)

maxillæ, projecting forwards, sometimes being even attached to the very tip of the nose.

The question of removing or leaving the pre-maxillary bone arises here, and the very best authorities have differed widely. Many have advised its removal, if it projected much, because (1) pressing it back is difficult and unsatisfactory; (2) if it be pressed back, it rarely

FIG. 180.



Hagedorn's operation for double hare-lip.

unites by bone; (3) in such a case it will act as a wedge, preventing closure of the alveolar arch and palate-fissure; (4) the teeth in it cannot be relied upon to come through usefully; and (5) a dentist can fit a plate that will answer the purpose quite as well. On the other side, Mr. Holmes (*Surg. Dis. of Children*, p. 108), argues thus: It is of the highest importance to preserve, if possible, this portion of bone, for these reasons: (1) if the bone be removed there must be a permanent gap through the hard palate. (2) There must also be a

FIG. 181.



(Holmes.)

flattening and malposition of the upper lip, in consequence of its having lost its bony support; and from this flattening of the upper jaw it will result that the lip will be very short and tense, and the patient extremely 'under-hung,' a very unpleasing deformity" (Fig. 181). To this I would add two more—that (3) the presence of this bone is needful for the preservation of the due width and arch of the bone, and (4) that such an arch will best carry artificial teeth, if any are needed owing to the unsatisfactory eruption of the natural ones. Thus most surgeons will prefer to follow Mr. Holmes' advice. Mr. Holmes, a little later, goes on to say that in a few cases it may be necessary to sacrifice the bone—*e.g.*, where it is very far forward, very much out of proportion to the neighbouring parts, and the child very weak.

I am of opinion that, if the following points be attended to, the pre-maxillary bone, however advanced and firmly based, can always be replaced and preserved; weakness on the part of the child, which is undoubtedly a matter of grave consideration in cases like this where the loss of blood is considerable, is best met by doing the operation in two stages—in other

words, being content to first get this bone replaced, and leaving the uniting of the soft parts till another time.

Where the stalk of attachment of the pre-maxillary bone is slender, and where there is plenty of room between the two maxillæ, it may often be broken back into place by the operator supporting with his left hand the back of the child's head, and then with his right thumb sharply fracturing back the bone. This should be done thoroughly, and, if needful, by the aid of non-serrated forceps covered with drainage-tube, or bone-forceps may be applied to the stalk in front and also behind till it is almost completely cut through. If now it can be replaced, but tends to come forward again, it should be sutured, on one side at least, to the maxillæ with sterilised chromic catgut.

If the maxillary bones on one side or both are in the way, and prevent the replacing of the pre-maxillary bone after it has been detached sufficiently, or if this is too voluminous, its sides must be cut away and the maxillæ also pared till the central piece can be pushed back between them and retained with a suture, as above advised.

A severer method—one, therefore, which should only be tried when all other means of replacing the pre-maxillary bone have failed—is to cut a wedge-shaped gap out of the septum nasi and to press or fracture the partially detached bone into the gap. Some have passed a suture* through the septum before the wedge is cut out, and then united the ends over the pre-maxillary bone to keep it in place.

The hæmorrhage may be very free in these cases where very vascular bones are cut through. I have generally found that it is at once arrested by suturing the bones; if it is thought needful to apply a fine point of actual cautery or of the thermo-cautère, where the child is very weakly, septicæmia may easily follow.

No cutting is to be employed here, if it can possibly be avoided. The objections to this step are given at p. 518.

It is absolutely necessary, by some means or other, to get the pre-maxillary bone quite back and to make it stay there, as otherwise the soft parts over the projecting bone, or the line of union, which often comes just opposite to it, will be pressed upon and give way.

So, where the surgeon is unable to get the bone back by any method, he may follow the advice of Sir W. Fergusson (*loc. supra cit.*), and, incising the mucous membrane over the bone, separate this sufficiently to introduce a small gouge about a quarter of an inch broad, scoop out the temporary incisors, and cut away the wall of bone, which for the first eight weeks consists of merely a few plates. By this the projection is removed, and the tissues which remain offer no obstruction to the union of the lip in front. Only the mucous membrane and some periosteum are left to form a soft cushion behind the united lip.† Furthermore, by this means the loss of blood is diminished.

Causes of Failure and Death after Hare-lip Operations.—Amongst the commonest of these are—(1) Feeble vitality. Marasmus. Many

* If he do this, the surgeon must be provided with needles of different curves. Small curved ones in a holder offer more variety than those in handles.

† This cushion can be stitched to the maxillæ, if needful.

infants die after hare-lip operations, but, while the effect of loss of blood and of pain must not be lost sight of, in most of the fatal cases death is due, not to the operation, but to feeble vitality. Whether operated on or not, the majority of these cases would have died in infancy. (2) Hæmorrhage. This, if serious, is due either to very free separation of the flaps in a weakly child, or (a cause much less excusable) to the coronary arteries not having been properly secured. Loss of blood will lead to non-union, but it may destroy life rapidly by a clot in the fauces and upper aperture of the larynx. One case has come to my knowledge in which, after operation, this untoward result would have happened, the child getting increasingly blue and breathless, had it not been for the prompt common sense of the nurse in charge, who fished out a large clot with a sponge on a holder. (3) Bronchitis and broncho-pneumonia. (4) Diarrhœa. (5) Asphyxia (p. 522). (6) Infection especially where the bone has been interfered with in a weakly infant, and under conditions always adverse to aseptic healing.

Repetition of Operation.—In the rare cases where primary union fails, all sutures are to be removed and the parts fomented with boracic acid lotion. As soon as all inflammation has subsided, the edges will rapidly cover themselves with healthy granulations. An anæsthetic should now be given, the parts are thoroughly cleansed and dried, and the edges wiped over with dilute formalin solution or pure carbolic acid. They are now carefully approximated with gauze and collodion, over which Meade's strapping should be applied. A good result will often be obtained in apparently hopeless cases. I may remind my younger readers that in many cases a perfect result cannot be secured by one operation. Where parents are likely to be unreasoning and unreasonable, the surgeon should warn them of this.

In cases unfavourable owing to the malformation or to the general condition (p. 517), hare-lips which have been operated on often cause disappointment, however much, up to the third day, they resemble pictures in books. Incomplete closure, below or above, a little inequality in the levels of the halves of the new lip, some flattening and closure of the nostrils—any of these may mar the first operation. The more operations a surgeon does, the more difficult and trying cases will he meet with. He can scarcely do better than remember the words of the great surgeon of Vienna (Billroth, *Clin. Surg.*, p. 79): "Operations on little children do not always succeed as well as could be wished, on account of the diminutive size and softness of the parts. The flaps of the lips cannot always be adapted as exactly as desired, and, even if this be satisfactorily accomplished, the result does not in every case quite come up to expectation, so that, some few years after, further slight proceedings become desirable, in order to improve the appearance." And again, a little later, the same surgeon, speaking of operations on "quite little children," says: "I decline to give any absolute guarantee with regard to the result in such cases."

OTHER PLASTIC OPERATIONS ON THE LIPS AND FACE

(Figs. 182 to 203).

These are very numerous, especially for the restoration of the lower lip after operations for epithelioma, &c., injuries, ulcerations, and burns. A few of the chief will be described here.

It will be convenient if, at this time, I add some general principles which should govern every operation of **plastic surgery**, large or small.

(1.) The patient should be in the best possible condition as to general vitality, healthy performance of the chief functions, appetite, &c.

(2.) If the deformity has resulted from tubercle or syphilis, a satisfactory condition, both constitutionally and locally, must have been secured by previous treatment. And it will be well, often, to continue constitutional treatment after the operation.

(3.) The parts to be operated upon must be rendered as aseptic as possible. Where the mouth is involved, this and the teeth should be thoroughly cleansed beforehand (p. 581).

(4.) Asepsis should be maintained as thoroughly as possible throughout the operation. The knife and instruments employed must be of the sharpest.

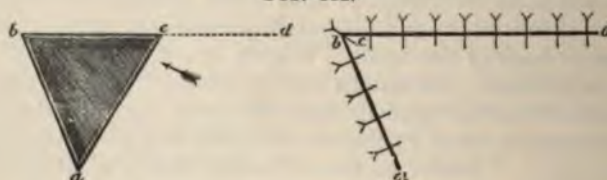
(5.) The flaps should be taken from healthy parts. As instances of the convenient sites for flaps, the side of the abdomen or region of the hip may be given where the ulcerated surface, *e.g.*, after a burn, is on the forearm or back of the hand. Where, in a child especially, the surface is about the knee, the thighs may be crossed in order that the skin may be taken from the opposite limb (Keetley, *Lancet*, Mar. 4, 1905). Fixity must be maintained by the use of plaster of Paris, with appropriate windows (p. 22). "Under no consideration should cicatricial tissue of a pale glossy surface be employed, for when its subcutaneous connections are severed it is almost certain to slough, especially when the result of a burn. If cicatricial tissue exist at the base of a flap, sloughing is quite likely to occur. Cicatricial tissue at the border of a flap is quite certain to die, and its presence there must not be estimated in computing the area of the new flap. When the flap is to be joined on three sides with cicatricial formation, the base must be made large, be highly vascular, and but little twisted, as the vascular supply at the sides will be very little added to by the new association" (J. D. Bryant, *Oper. Surg.*, vol. i. p. 507).

(6.) Each flap must be cut thick enough, carrying with it the subcutaneous tissue, and large enough; "as a rule, one-sixth larger than the space it has to fill" (Treves, *Operat. Surg.*, vol. ii. p. 3). "Reparative flaps should always be made large enough to allow of at least three lines of shrinkage for each inch of width of their surface" (J. D. Bryant, *loc. supra cit.*). As an instance of the size required, Mr. Keetley gives the case of a child with a large hairy mole on the face. After this was excised and the arm brought up to the head, nearly all the skin on the inner aspect from the shoulder to the elbow was needed for the pedunculated flap employed. The same authority advises the use of a pattern for the flap, cut out of boiled india-rubber sheeting.

(7.) There must be no tension whatever on the flaps when they are brought into apposition. Tension is one of the most frequent causes

failure after a plastic operation. The chief aids in securing this most important end are: (a) *Cutting the flaps sufficiently large.* (b) *Undermining the flap or flaps.* Julius Wolff elaborated this method of closing large gaps (*Berl. Klin. Woch.*, 1890, No. 6). It is thus described by Messrs. Watson Cheyne, C.B., and Burghard (*Man. of Surg. Treat.*, vol. i. p. 178):—"In small wounds the knife is carried between the superficial fat and the deep fascia; in extensive ones it should be swept between the deep fascia and the muscles, and by this means the skin and fascia are raised from the deeper parts for a considerable distance around the wound. The undermining should be carried on until the edges of the wound can easily be brought into contact by pulling upon them. In raising these flaps great care must be taken to direct the edge of the knife towards the deeper parts, and not towards the skin: failure to observe this precaution is apt to result in scoring of the flap, and as the blood-vessels which supply the skin ramify in the subcutaneous fat, the blood-supply to the edges of the wound might be cut off, and sloughing might ensue. The freeing of the edges of the wound by undermining must be carried out sufficiently widely to allow them to come together without endangering the circulation in the flaps. If it has not been done sufficiently freely, the flaps will become white on putting in the stitches, and after waiting a little the circulation will not

FIG. 182.



be restored; it will therefore be necessary, in such a case, to carry the undermining further, when the flaps may be brought together without being permanently blanched. If at first there be a little whiteness in the immediate vicinity of the stitch, it will disappear in a few minutes when the tension is not too great." (y) By making *liberating incisions* at a short distance from the wound, lateral or horizontal as required, before inserting the sutures in the lips of the wound. These incisions cause slightly gaping wounds after the defect has been closed, but these usually heal rapidly by aseptic granulation. (δ) By the use of *flaps*. These may be (a) *broad and glided*, (b) *pedunculated*, (c) *granulating*.

(a) Fig. 182 shows how a triangular gap may be closed by gliding in a flap raised by a horizontal incision. But in these cases it is preferable to convert the horizontal incision *c d* into one curving outwards and downwards. Such an incision better frees the flap *a c d*, which is to be glided, and is likely to leave a less conspicuous scar, as it can often be made to follow a natural sulcus. Where the gap is very large, two such freely curved incisions are made, one on each side of the gap. In the removal of extensive epitheliomata of the lower lip, when a very large triangular gap is left, such freely-made curved flaps enable the surgeon to close the gap better than those which have the authoritative names and which are shown below (*e.g.* Fig. 190)

(b) Flaps with pedicles.—These may be so fashioned (as in Fig. 183, where a quadrangular gap is being closed) that the flaps are again little more than glided. In other cases the pedunculated flap must be cut in accordance with the principles already enunciated. The pedicle must

FIG. 183.



Bruns's method of closure of a quadrilateral gap by two lateral flaps. (Tillmanns.).

be as wide as possible. The flap itself must be from two to three times as large as the area which it has to cover. It must be raised as thick as possible, its apparent bulkiness being greatly diminished later. In many cases it will have to be "jumped" over intervening undetached soft parts. The directions given above as to a pattern and the use of plaster of Paris must be remembered. When the pedicle is divided, the parts must be carefully steadied and approximated.

(c) One more class of flaps must be mentioned, that of *granulating flaps*.

This method was used with much success, especially in cases of cicatrices after burns, by Mr. J. Croft (*Med.-Chir. Trans.*, vol. lxxii., 1889, p. 349). Where the gap is a large one, the flaps being necessarily long and somewhat narrow, and therefore possessing but a limited blood-supply, Mr. Croft advised that the flaps be dissected up and left attached at each end, and allowed, together with the wound, to granulate before the flap is moved. Mr. Croft claimed the following advantages for this method, and his claims were made good by the cases which he showed: 1. The risks of sloughing of any part are greatly diminished. Instead of being transplanted when recently drained of blood and reduced in temperature, it is removed when abundantly vascular and full of active, living, plastic matter. 2. The transplantation being made two or three weeks after the first operation, the local effects of shock are avoided or reduced to a minimum.

The skin having been carefully sterilised, long lateral incisions are made down to the deep fascia, and then the flap, usually straplike in shape, is carefully undermined throughout and completely separated from the deep fascia. It is cut uniformly and as thick as possible, especially in its centre. It may have to be from 8 to 9 inches long and 3 inches wide. A piece of sterilised green protective is then placed between the flap and the bed from which it has been raised, and this, renewed as needed, is kept in situ for seven or twenty-one days. At the end of this time the scar is freely divided from the flap and the flap is moved into healthy tissues, and its ends are dissected up above and below. The flap, when moved, will have become

FIG. 184.



Patient before operation. (Croft.)

shorter and narrower and loaded with plastic material, is cut across at its distal end ; it is next trimmed and pared to a certain extent by refreshing its edges and its under surface for nearly or quite half of its extent, then transplanted into the wound, and carefully sutured

FIG. 185.



The same patient five years after operation. The dotted lines show the site and extent of the strap of skin which was raised and transplanted. (Croft.)

with well-sterilised salmon-gut and horsehair. If the free end of the strap-like flap die, then the whole flap will begin to contract and retract, but sufficient union will probably take place to anchor it in satisfactory position. If necessary, the flap must be kept in place

FIG. 186.



The patient before operation. The web of skin and the strap-like flaps of skin were

dotted
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by strips of iodoform gauze wrung out of 2 per cent. lysol solution, and fastened by iodoform and collodion. "A stranger to this mode of operating would have been very disappointed at the appearance of the parts at the completion of the operation, as the transplant looked so thick, clumsy, and narrow, and a considerable part of the fresh wound remained uncovered by flap." Again, "At first the transplant looks very ungainly, unsightly, and unpromising. As week after week goes by, the sausage-like thing flattens down and spreads out, until, finally, it may become twice as wide as it was originally cut."

While Mr. Croft's results abundantly justify a resort to this method, it is a tedious one, nine to twelve months being sometimes needed in a severe case; it is a painful one, as the second stage may have to be repeated; and it draws largely on the reparative powers of the patient. For these reasons most surgeons will prefer to try, first, what can be



FIG. 187.

After operation. The greatly improved position of the limb is manifest. The dotted lines show the situation into which the flaps have settled. (Croft.)

effected by a very free division of the scar and then careful Thiersch's grafting (p. 233).

(8.) All hæmorrhage must be thoroughly arrested; any ligatures used must be of the finest.

(9.) Each flap "must be gently handled, carefully adjusted, and most tenderly and precisely sutured" (Treves, *Oper. Surg.*, vol. ii. p. 3).

(10.) The sutures, of sterilised salmon-gut and horsehair, must be inserted so as to uniformly distribute the slightest remaining tension.

must be carefully maintained during the healing of the

stiffness on the part of the patient is to be expected, common burn-scars on the neck or upper arm, e.g., plaster of Paris applied after the

FIG. 188.



The dotted lines show the operation of Serre, the continuous ones that of Syme. The central part of each runs too near to the growth. The same remark applies to several of the succeeding figures.

FIG. 189.



The quadrangular incisions on the chin will indicate the method of Chopart. The chief objection to this method is that the central flap brought up from below tends to slide down. The triangular incisions show how a growth at the corner of the mouth may be dealt with. (After Serre.)

FIG. 190.



Dieffenbach's method of cheiloplasty. (Esmarch and Kowalzig.)

FIG. 191.



V. Langenbeck's method of cheiloplasty. (Tillmanns.)

FIG. 192.



Cheiloplasty by the method of Bruns. (Tillmanns.)

As pointed out above (Fig. 188), the incisions in many of these illustrations are drawn much too near to the growth.

method used in Fig. 17, p. 22, should be kept applied, from the first, to the head and neck, upper trunk and limb, or the flap will begin to ulcerate and irreparable mischief will be done.

Removal of Epithelioma of Lower Lip. Restoration of Lip. While I have retained Figs. 188 to 192 on account of the eminent names which they bear, and because owing to the differences presented by individual cases they may be of service, I am strongly of opinion that carcinoma here should be removed on the lines shown in Fig. 193.

Two dangerous fallacies appear to me to exist with regard to this operation: (1) That when occurring on the lip, because at first often warty, and in a dry and exposed position, it is a slow and less important form of carcinoma; (2) it follows that the operation is too often considered a trivial one, one for which the classical V-shaped incision suffices, and, as it is followed by rapid healing, that removal of an epithelioma of the lower lip is, in fact, anyone's operation. My own opinion is a very different one. I hold that, owing to carelessness and want of common sense on the part of the patients—and they are not always hospital ones—by the time they come to us, the glands here, as with carcinoma elsewhere, are often affected. Again, from the number of cases with which I have had to deal in which the disease has reappeared after the usual operation has been performed elsewhere, I am of opinion that a simple V-shaped incision is rarely justifiable. In later years I entirely abandoned it; where, as is most frequent, the disease occupies the neighbourhood of the angle of the mouth, two V-shaped incisions should be employed (Fig. 193); where the lip is extensively involved, three such incisions (Fig. 193) are called for.* Further, in the great majority of cases, owing to the duration of the disease, the lymphatic glands in the

FIG. 193.



The above show the way in which an epithelioma of the lower lip, whether involving the centre or one angle of the mouth, should be dealt with

* Not only is the actual epithelioma to be removed, but also the surrounding tissue, as it is also be widely removed owing to the degeneration on the border-land of carcinoma. The knife should be used from the actual disease.

submental and submaxillary regions should be investigated, even though they cannot be felt to be enlarged.* Until removal of epithelioma of the lip is carried out on the above lines, I hold that, if a large number of cases were carefully watched and the results of operation noted, the results would be found to be most discreditable, first to the common sense of the patients, and secondly to surgery. No one who is familiar with the practice of a large clinique, or collections of cases such as those provided for the examinations at the College of Surgeons, will be able to deny that the above remarks apply not only to epithelioma of the

FIG. 194.



Operation for removal of epithelioma and restoration of lower lip. The objection to this method is that it opens up the submaxillary regions only. In order to remove the submental glands, the tissues over the chin must be turned down. The after-difficulty of keeping these up in place may be met in part by suturing them with buried sterile chromic gut sutures to the periosteum of the mandible. The wedge-shaped incisions (Dowd) (foot-note, p. 537) facilitate the meeting of tension, and fitting the flaps in place.

tongue, but also that of the lip, trivial as is often the beginning of the disease, and, always, under the notice of the patient.

Restoration of Lower Lip. I will suppose that the surgeon has operated widely on an epithelioma here, removing it by two or more V-shaped incisions, and that he has to restore the lower lip and cover in the greater part of the chin, on one side at least. *The method of taking*

* This should certainly be a rule in hospital patients owing to their carelessness and lack of common sense attention. When the submaxillary or submental group can be felt to be enlarged the deep cervical group should also be removed. See the remarks on infection of the glands in epithelioma of the tongue, and those on removal of epitheliomatous glands in the neck (p. 603).

flaps from the neck will be given first as on the whole preferable for reasons given below.* From the apex of the central V-shaped incision one or two curved incisions are carried as in Fig. 188, only on freer lines, down to the level of the hyoid bone and then backwards and slightly upwards to the angle of the jaw. The following points require attention. The flaps must be cut thick enough to carry the facial artery in order to maintain their nutrition. The bleeding will therefore be very free and abundance of Spencer Wells' forceps must be at hand. Further, as the deeper cellular tissue will be opened up every precaution must be taken before, during and after the operation to keep the wound as sterile as possible. The flap must be raised evenly and without scoring. The lips of the central V-shaped incision are now brought together in the horizontal position to form the new lip, the cut edge of the mucous membrane being sufficiently freed to enable it to be united to the edge of the skin without tension, by numerous horsehair sutures introduced with very fine needles. The edges of the flap or flaps below are then united vertically, at first with stout salmon-gut, silver wire and horsehair. Hare-lip pins are permissible here as the scar points they leave are of little importance. But it must be understood that it is only by cutting the flaps on very free lines that tension will be obviated. Drainage should be employed on either side at the most dependent spots. If tension cannot otherwise be met,† the lower edge of each curved incision may be undermined to admit of its coming up to the upper edge. I prefer dry dressings of sterile gauze strips kept in place with iodoform and collodion for all the upper part of the wound; and a boracic acid fomentation for the lower part where the drainage-tubes come out.

In the second method the flaps are taken again by freely curved incisions, but here not from the neck chiefly but *mainly from the cheeks*. The two incisions now start not from the apex of the central V-shaped incision but from those at the angles of the mouth. They are carried straight outwards, at first, to the masseter muscle; here they curve outwards and downwards over the mandible and then forwards in the submaxillary regions nearly as far as the hyoid bone. Where the defect is unusually large, the first part of the incision must go beyond the masseter within an inch or so of the auricle before it is curved downwards. It is only by the freest operating that really large gaps can be closed. It is well to make this first part of the incision gradually until the mucous membrane is reached. This must be divided horizontally with one cut of sharp scissors on a level higher than that of the skin. This detail prevents somewhat the retraction of the mucous membrane. As the lower part of the flaps are being raised the mucous membrane is again cut first vertically at the anterior border of the masseter, and again, horizontally, at the line of its reflection on to the gum. Care must be taken in raising the first part of the flaps not to injure the parotid gland. When the flaps have been sufficiently raised they are glided and pulled inwards so that the edges of the central V-shaped incision

* I will take this opportunity of saying that in extensive operations of this kind, where there is likely to be much bleeding, a trial of Trendelenberg's position should always be made.

† Cutting wedge-shaped gaps in the flaps (Dowd) (Fig. 194) may relieve tension in and facilitate the fitting of the flaps in place.

FIG. 195.



(Watts.)

FIG. 196.



(Watts.)

meet in the middle line. The same details with regard to freeing the mucous membrane if needful before uniting it to the skin, preserving the blood-supply and drainage, must be observed as in the method first described. In either case the state of the submaxillary and submental lymphatic glands must be cleared up. In both small triangular gaps may be left at the outer ends of the incision. These are closed by skin-grafts. While in the second method it is easier to provide sufficient mucous membrane for completing the new lip, I prefer the one first given. It avoids the scars on the face, the damage to the lower branches of the facial nerve, and, by it, it is easier to keep the facial artery intact.

Regnier's Operation. Here the incisions are fewer and the scarring

FIG. 197.



(Watts).

is less, as a large flap, having its nourishment from either side is undermined and glided up over the chin from below. The epithelioma is removed, with the greater part of the lower lip, by an incision curving downwards somewhat from one angle of the mouth to the other nearly to the point of the chin. All bleeding having been arrested, the cut edge of mucous membrane where it passes at its reflection on to the mandible is freed and stitched carefully to the skin to form the edge of the new lip. A free incision, about 5 inches long, is made from side to side in the neck, with its centre at a point 3 or $3\frac{1}{2}$ inches below the middle of the wound by which the lip has been removed. The tissues between the two incisions above and below the chin are now undermined and the broad strap-like flap with pedicle, one on either side, is glided upwards over the chin in position, its lower margin, that which corresponded to the original lower lip, is sutured

with sterilised catgut to the periosteum over the lower margin of the mandible. When the flap has been thus raised a gap is left in the submental region which will, in part at least, require skin-grafting (p. 233).

The advantages of this operation have been mentioned above. On the other hand, where the chin is prominent it is not an easy matter to thoroughly undermine the tissues which form the broad collar-like flap so as to free them sufficiently, at the same time using the knife on a uniform plane without any scoring. Further, in cases where the glands required removal the submental and submaxillary regions are not opened up as conveniently as by the other methods.

In some cases where the gap is very extensive, where the patient is young, and where it is especially desirable to avoid scars, it may be preferable to resort to *the skin of the arm* for the flaps required. Figs. 195 to 197 illustrate an excellent result obtained with this method by Dr. S. Watts of the John Hopkins Hospital (*Ann. of Surg.*, Jan., 1905, p. 118).

A boy *æt.* 15 was admitted July 6, 1904, having had his lower lip, including the periosteum of the mandible in places, bitten off two days before by a circus pony (Fig. 195). The wound was clean and free from infection. A flap, including skin and fat, 12 cm. wide and 18 cm. long, was dissected up from the right upper arm (Fig. 196). Its under-surface and the raw surface of the arm from which it was taken were covered with grafts from the thighs. All these took well, and in ten days the flap was covered with skin on both sides. Some of the skin on its under surface was intended to form a substitute for mucous membrane and, to some extent, prevent contraction. Severe bronchitis delayed further operative proceedings for more than a month. During this delay, the flap, which had become much shortened by the sloughing of its distal extremity, contracted greatly. On Aug. 18 the flap, dissected up somewhat further, in order to lengthen it as much as possible, was sutured by its free extremity to the left side of the wound in the lip. A small portion of the vermilion border, which had been preserved on this side, was sutured along the upper edge of the flap. The arm was held in place by a plaster cast for about three weeks. The flap was then severed from the arm. This was done under local anæsthesia in several stages, to allow the circulation to become more perfectly established. At two subsequent operations, at intervals of two or three weeks, the lower and right borders of the flap were trimmed and sutured in position. The admirable final result is shown in Fig. 197.

Replacement of Lip. I refer, here, to those cases occasionally met with in children where, after burns about the upper neck, the lower lip and chin are tied downwards by scar tissue. This is another of those instances where, from the site of the area to be operated upon and the age of the patient, a resort to the skin of the arm for one of the flaps required, is indicated. The following case, under the care of Mr. W. H. Brown of Leeds (*Brit. Med. Jour.*, Jan. 7, 1905, p. 20), indicates the steps that may be resorted to. The paper is accompanied by photographs which show the admirable result achieved. The child was aged 11. To stop the dribbling from the mouth, a cut was made across the throat from angle of jaw to angle, and the head pushed up into the erect position. To close the wound, about 3 inches wide, which resulted, two flaps were taken from the shoulders and turned inwards to meet beneath the point of the chin. The result of this operation was to rid the patient of all dribbling. To remedy the eversion of the lip, "as there was no available skin on the neck which seemed likely to be of use, a straight incision was made just below the red border, a

stitch put through the red border, and the lip drawn up into a natural position. The right arm was then brought across the face and fixed so as to allow of an ample flap being raised from over the middle of the arm, and then laid into the space below the lip. This flap was left attached to the arm and stitched with silk sutures into its new position. A fortnight later the arm was set free from the face, and the flap was found to be living and healthy. The freed edge was stitched down level and the skin cut." The following practical points in the after-treatment of such cases are emphasised. "One is to keep the child quiet by means of small doses of opium for the first four or five days, increasing the dose about half an hour before the first dressing. When possible, it is best to change the dressing for the first time under an anæsthetic. Difficulty of feeding was in this case got over by means of a tube and funnel. She had all her nourishment for a fortnight by this method. Absolute fixation of the head was secured by using large

FIG. 198.



FIG. 199.



Utilisation of red margin of upper lip for the restoration of the orifice of the mouth.
(Esmarch and Kowalzig.)

sand-bags on either side of the head with a strong brow band across the forehead."

Restoration of Mouth.—This is sometimes required when extreme narrowing follows on an operation for removal of the lower lip, in which the surgeon has been compelled to trench upon the upper, or on cicatricial healing of ulceration due to burns, lupus, noma, &c.

In cases where the margin of the lip is diseased in its whole extent, and where, after removal of the disease, the mouth may become too small, a part of the red margin of the upper lip may be utilised in the restoration of the orifice of the mouth (Figs. 198 and 199). Sufficient of the vermilion border is detached from the upper lip to allow of the strip thus made loose being drawn around the orifice of the mouth and forming an edge for the lower lip without tension.

In other cases the **Method of Dieffenbach** may be employed in these cases (Figs. 200 and 201).

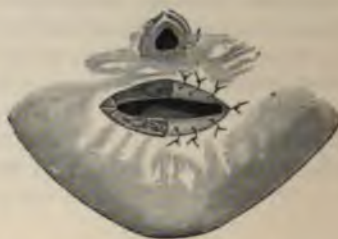
This surgeon, so famous for his plastic skill, proceeded somewhat thus: Two lateral incisions are carried from the opening of the mouth through the whole thickness of the cheek, sufficiently far to ensure the new mouth being of proper size. After this the mucous membrane is sufficiently detached (a matter often difficult to do without causing subsequent sloughing, owing to the cicatricial contraction of the parts)

from the skin to allow of its being stitched as an edging all round the opening of the new mouth. Very sharp knives are especially needed here. The surgeon must aim especially at securing that the skin and mucous membrane meet exactly at the angles of the new mouth, for if primary union of the skin and mucous membrane be not secured here, re-contraction of the new opening will certainly follow. In some cases, instead

FIG. 200.



FIG. 201.



Dieffenbach's method of restoring the size of a contracted mouth.
(Esmarch and Kowalzig.)

of dividing the whole thickness of the cheeks by lateral incisions it is better to dissect off thick triangular flaps of skin and subcutaneous tissue with their bases placed outwards on the cheeks. The scar tissue is next freely divided so as to sufficiently enlarge the mouth. The flaps

FIG. 202.



The dotted lines show the operation of Sédillot, the continuous ones that of Dieffenbach, for making a new upper lip. (After Serre.)

FIG. 203.



Restoration of one angle of the mouth. (After Serre.)

are then turned inwards and sutured to the mucous membrane so as to form satisfactory new angles, and prevent any re-contraction.

To prevent re-contraction Hüter has advised the wearing of a dilator made of ebony or hard india-rubber, of the shape of a funnel, with two rims to maintain it in place.

Upper Lip.

(i.) Operation of Sédillot by Vertical Flaps (Fig. 202).—Flaps quadrangular in shape are raised by the following incisions: (1) the

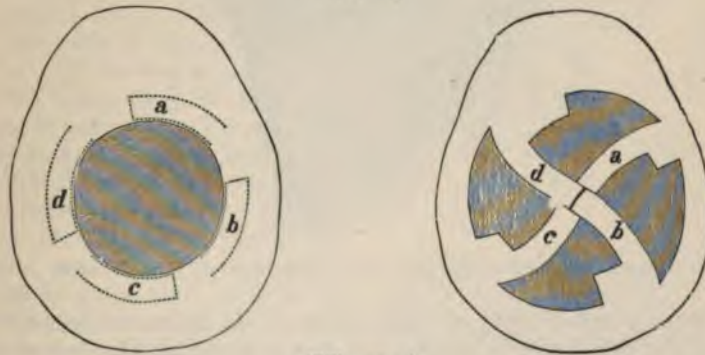
internal one, starting from a point midway between the angle of the mouth and the lower eyelid, and ending usually at a point on a level with the prominence of the chin; (2) a horizontal one passing outwards from the lower end of the first for half an inch to two inches; and (3) a second vertical incision passing upwards from the outer end of the horizontal one to a point on a level with the ala of the nose.

These flaps, comprising the whole thickness of the cheeks, are moved inwards so that their lower extremities meet vertically in the middle line.

(ii.) **Operation of Dieffenbach and Chauvel by Vertical Flaps.**—Here the flaps are cut in the reverse direction from that of Sédillot. This method is to be preferred, as, owing to the base being below, there is less tendency for the new lip to be raised by the contraction of the scar, and thus to expose the upper teeth (Fig. 202).

(iii.) **Operation by Lateral Flaps.**—Here the flaps are taken laterally from the cheeks. They should be cut of the full depth of the new lip,

FIG. 204.



(Tillmanns.)

and at their outer extremities should curve downwards so as to diminish the tension.* Their inner extremities are united in the middle line below the nose.

(iv.) **Serre's Operation for Restoring One Angle of the Mouth.**—Figs. 189 and 203 show the steps which would be adapted for restoring one angle of the mouth, which has been distorted by cicatricial contraction; a similar proceeding being available for a growth situated here.

Restoration of Defects on the Cheek.—While surgical interference is less frequently called for here than for restoration of the lip, greater difficulties are present. The chief of these are the less mobile condition of the part, the vicinity of the facial nerve and parotid duct, and in many cases the fact that morbid conditions causing cicatricial contraction and fixity are often met with here. The widely different nature of the operative steps required now will be seen when the chief

* Dr. Port, of New York, who figures this operation and numerous other methods from Szymanowski (*Handb. d. Chir. Med.*, Braunschweig, 1870), lays stress upon this precaution (*Inter. Encyc. Surg.*, vol. v. p. 489).

indications for restoration of the cheek are considered, viz., those arising after removal of such growths as epithelioma, and such cases as

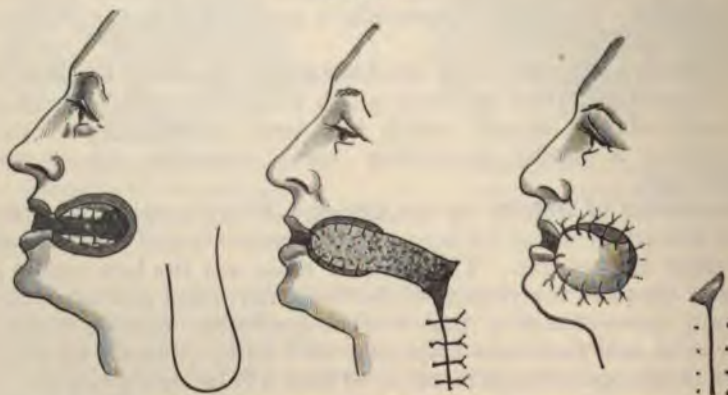
FIG. 205.



One method of closing a gap in the cheek by a gap from the neck.

those after gunshot injury or cancrum oris. In these two last not only is there the deficiency to remedy but this is probably hide-bound at its periphery, and a varying degree of ankylosis of the jaw is often present

FIG. 206.

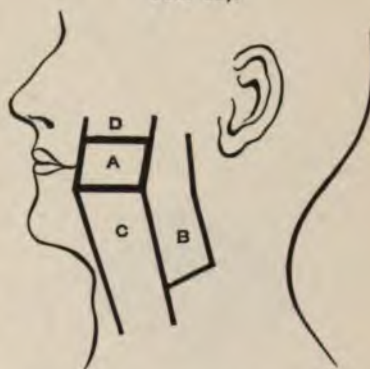


Israel's method of closing a gap in the cheek by a flap taken from the neck : this flap may have to reach almost to the clavicle. The flap is reversed, and its outer surface skin-grafted or covered in by a second flap. (Esmarch and Kowalzig.)

as well. Fortunately these cases are uncommon. My space will only allow me to allude to two classes of cases. (A.) Where there is a large gap and little or nothing to be got from the cheek. Such a case results from extensive removal of an epithelioma of the buccal mucous membrane. My experience is that it is useless in these cases to slit the cheek and then dissect out the epithelioma, leaving the skin. Reappearance of the disease is certain. If any operation is undertaken the whole thickness of the cheek must be widely removed. The prognosis is always grave, and the gravity increases with the difficulties of the operation the farther back the mucous membrane is involved.

The surgeon who has to fill in a large* gap in the cheek where the only skin left is that fixed above to the malar bone and infraorbital region and below to the mandible, can take his flap from the forehead or the neck. The former skin has the advantage of being hairless, but the resulting deformity is greater. The pedicle of the flap lies here above the root of the nose or the zygoma.† If the flap is taken from the neck (Figs. 205 to 207), the scarring is much less, but the vascularity is not so good, and if the flap contain hairs it must either not be inverted, as hairs will continue to grow into the mouth indefinitely, or, if this is necessary, the pedicle must start well below the jaw so that the flap, which will have to extend nearly to the clavicle, is hairless. A considerable area will thus have to be "jumped" when the flap is sutured in position. At a later stage the pedicle must be divided and the flap trimmed and fitted into its place. I do not recommend the use of double flaps, owing to the great interference with soft parts which is entailed in patients whose vitality is often by no means good, and who are not well adapted for prolonged anæsthesia. The surface of the inverted

FIG. 207.



To show, diagrammatically, one method of closing a defect in the cheek. A. Area involving entire thickness of cheek excised. B. Flap carried up from the neck and inverted so that its cutaneous surface replaced the mucous membrane of the cheek. It was sutured to the gum above and below and adhered readily. C. Flap glided up from the neck to cover the raw surface of B. D. Flap glided downwards for the same purpose. (Haynes.)

* Where the gap is a moderate one but too large to admit of being closed by undermining and gliding the edges of the tissues left, a flap may sometimes be taken from the masseteric region with its base near the gap. The flap is turned forwards so that its skin surface looks into the mouth, the raw surface being grafted. This is only applicable to cases where the skin is without hairs. Care must be taken not to injure the parotid gland and duct, and as far as possible, the branches of the facial nerve.

† Senn, in a case in which the entire cheek had been removed for epithelioma, turned down a fronto-parietal flap—the patient was the subject of extensive alopecia—so that the skin surface replaced the mucous membrane. A flap from the neck and an additional one from the scalp covered the raw surface and maintained the blood supply (*Ann. of Surg.*, Oct., 1904, p. 601).

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flap should be grafted by Thiersch's method at the time. The wound in the neck will be mainly closed after the edges are undermined, the rest being effected by skin-grafting. As in the case of the lower lip,

FIG. 208.



(Esmarch and Kowalzig.)

FIG. 209.



(Esmarch and Kowalzig.)

FIG. 210.



(Esmarch and Kowalzig.)

the question of taking the flap from the arm in suitable cases (p. 540) must be considered.

(B.) In cases where the chief condition calling for repair is not so much a deficiency of skin as cicatricial contraction of the mucous membrane and fixity of the jaw, Gussenbauer's method in two stages

should be employed. All cicatricial tissue having been removed and divided and the mouth opened as far as possible, a flap of skin and subcutaneous tissue with its base situated over the masseter, or, if needful, still farther back in front of the lobule, is dissected up between this muscle and the gap. It is then turned into the mouth round the anterior edge of the masseter and sutured to the mucous membrane over the internal pterygoid with sterilised catgut on fine curved needles. In about four weeks, when the vascularity of the flap around its edges is assured, the base and posterior part of the flap are dissected up and turned forwards into the remaining part of the gap to form a new angle. It is then grafted or covered with a second flap taken from below the mandible. Of the objections to double flaps in these cases I have spoken above. The same assiduous attention will be required as in other cases of fixity of the jaws (p. 542), and Esmarch's modified operation (p. 513) may be required.

In extensive gaps in children, where the confined position is better borne, the flap may be taken from the inner side of the arm, the parts being secured by plaster of Paris (p. 538). In those very rare cases where after injury or sloughing the nose, upper lip, lower lids and cheeks have disappeared, a paper by Senn (*New York Med. Journ.*, June 20, 1903) may be consulted. Here a huge flap was taken from the scalp. The operative procedure was divided into about ten stages. Fig. 204 shows a method introduced especially for closing a gap on the scalp, which, used on a small scale, and combined with Thiersch's method of grafting, may be found useful on the face or cheek.

Defects of the Eyelids.—Figs. 208 to 209 show different methods of curing that troublesome condition known as ectropion. Fig. 210 explains how a growth around the inner canthus may be removed without deformity.

CHAPTER IX.

OPERATIONS ON THE PALATE.

OPERATIONS FOR CLEFT PALATE—REMOVAL OF GROWTHS OF THE PALATE.

OPERATIONS FOR CLEFT PALATE (Figs. 211 to 242).

Age for Operation.—The tendency here is to operate at earlier dates than heretofore, on account of the gain of better power in taking food and the earlier improvement in the voice. Before deciding on this point, each operator must take into consideration the general health, the vitality and nutrition of the patient, together with the width and length of the cleft, the degree of delicacy of the tissues bounding it, the size of the mouth, the height of the vault of the palate (p. 550), and, lastly, his own operative skill in this particular field of surgery. The surgeon will do well to remember that it does not in the least follow that because operators of special experience have operated successfully in the first few weeks or months, it will be wise for him—a man, perhaps, of much smaller operative experience—to do so also. This matter has been referred to before (p. 516). What is wanting and what would help us greatly is a detailed list of cases operated upon in early life, with all the results. And the same advice applies to the amount attempted at one operation. Because nearly all* authorities on this matter advise closure of the whole cleft at a sitting, it does not follow that this is a wise course for those to pursue whose opportunities have been much fewer. With regard to the argument that cleft palates require operating upon in infancy, because of the difficulty of nourishing the patients,† I would reply that this difficulty can generally be met by

* Mr. G. A. Wright, of Manchester and the Pendlebury Children's Hospital, is an exception. In quite young children with complete clefts he considers it an advantage to close the soft palate alone first, and the hard a few months afterwards (*Diseases of Children*, third ed., p. 165). The soft palate is the essential part in which to secure primary union (p. 552).

† Cases are very rare in which sufficient food cannot be given by one of the following methods (especially after any co-existing hare-lip has been closed), if only sufficient pains are persevered with—viz., a small spoon passed well back into the mouth; a feeding-bottle with a teat big enough to fill the gap, the teat being perforated underneath for the escape of the milk, only a little being given at a time; an ordinary feeding-bottle, with a leaf-like piece of india-rubber attached above the teat, so as to fill up the gap (as advised by Mr. Coles); finally, sometimes deglutition will be facilitated if the nurse closes the nostrils with her finger and thumb every time the child swallows, or feeds the child well propped up. It is often advisable to take these cases into a hospital or into a home, and

persevering care, and, where this is not the case, the little patient is not likely to be in a state fit to meet what is one of the severest operations in infancy.

With regard to the voice, while there is no doubt that the earlier a successful operation is performed the better will be the voice, it is possible that this has been too strongly put forward, to the exclusion of the other side of the question. Thus, the possibility of an unsuccessful operation, with the inevitable loss of tissue, and scarring of what remains, has been too much kept in the background. And children under two years of age cannot have contracted a habit of speech so bad as, of itself, to call for operation before this date. Again, the fifth year is the earliest period at which those systematic lessons in improving the speech, which are so essential a part of the after-treatment, can be undertaken.

The late Mr. Davies-Colley (*Trans. Med. Soc.*, vol. xix., 1896, p. 70) stated that when he had the opportunity of choosing the age he preferred fourteen months. Mr. E. Owen (*ibidem*, p. 68) gave his opinion that "For a soft palate, the child being in good health, the time for operating is somewhere in the first six months, I think. For a hard and soft palate together, it is, I think, in the second year." Later on the same surgeon (*Cleft Palate and Hare-Lip*, p. 41) considers that the most favourable time for operating (by Brophy's method, described below, p. 570) is between the ages of two weeks and three months. Mr. Clutton (*St. Thomas's Hosp. Rep.*, 1896, vol. xxv. p. 121) writes: "I believe that a very large proportion of the worst cases of cleft palate can be safely operated upon before the second year is completed." Mr. W. A. Lane (*Cleft Palate and Hare-Lip*, 1905, p. 42, writes: "The best time is the day after birth, or as soon after that as possible."

Writing as I do for the guidance of many of my younger brethren, I consider that, unless Brophy's method is proved by a number of published cases to give better results, which from those related by Mr. Berry and Dr. Ferguson of Chicago (pp. 572, 573) appears to me to be extremely unlikely, the end of the first year should be reached before a cleft of the soft palate should be operated upon, and then only under favourable conditions, and that the patient should be two years old, at least, before a complete cleft is operated upon. As experience is gained, operations may, no doubt, be performed successfully at an earlier date, but at any time during the first year of life the risks of failure are great, owing to the effects of hæmorrhage, the readiness with which convulsions are excited, the liability to bronchitis and diarrhœa, and, lastly, the delicacy of the soft parts and the readiness with which they tear. I am very glad to be supported here by an old friend, G. A. Wright, formerly Surgeon to the Children's Hospital at Pendlebury, Manchester, and also Surgeon to the Manchester Infirmary. This authority states (Ashby and Wright's *Diseases of Children*, p. 171): "We are not inclined to attempt closure of a severe case of cleft of both hard and soft palates earlier than the third year at soonest." Mr. Berry's advice (*Brit. Med. Journ.*, Oct. 7, 1905) from an experience of 67 cases is as follows:—"I have never operated during the first

put them under the care of a specially trained nurse. The nutrition is usually at once improved, and the mother can be taught to maintain the improvement until the child is about two years old.

twenty-two months of life, believing as I do, that some time during the third year of life is, in the vast majority of cases, the time at which the operation is undertaken with most advantages to the patient." Mr. R. W. Murray, of Liverpool, whose name carries great weight, prefers, "as a general rule, to postpone operating upon the palate until the child is between two and three years of age, and then at one operation completely close the cleft" (*Brit. Med. Journ.*, Feb. 3, 1906, p. 245). I may add that American surgeons whose eagerness to make trial of new methods is well known, are not, as a rule, in favour of very early operations, preferring the age of three to four, or later (*Trans. Philad. Acad. of Surg.*, Feb. 1, 1904; *Ann. of Surg.*, June 1904, p. 1029; *Trans. New York Surg. Soc.*, Oct. 25, 1905; *Ann. of Surg.*, Jan. 1906, p. 136). While I am in entire agreement with this view, I will take this opportunity of advising my younger readers, whichever course they follow, to operate on one uniform plan, so as to secure as much skill as possible in an operation which is not very common.

Order of Operation on Lip and Palate.—Another question that has been raised with regard to operations on cases of cleft palate in infants is whether the cleft palate or the hare-lip, which usually complicates the cases, should be taken in hand first. Mr. W. A. Lane has strongly advocated (*loc. supra cit.*) leaving the hare-lip until the cleft palate is closed, as the gap in the lip facilitates closing the cleft in the palate. This is, no doubt, a very important point, but there are others to be considered. In most cases Mr. Lane, who considers the first few days after birth as the best time for operation (*infra*, p. 563) completes both operations under the same anæsthesia (*infra*, p. 570). Those who do not possess Mr. Lane's especial experience and skill must consider what will be the condition of the child if the operations performed in the very early days of life fail. While I admit that the gap in the lip renders operations on the palate easier, I consider that this point will be found to lose much of its importance. If, as I advise, the hare-lip, for the sake of the child's nutrition and the feelings of the mother, has been closed when the infant was two to three months old, and if, when the cleft palate is taken in hand at about the age of two to three years, it is found that the lip is very tight and interferes with the satisfactory use of a gag, there should be no doubt whatever as to slitting the lip before an attempt is made to close the palate. I have found the adoption of this step and closing the slit after the operation on the palate give most satisfactory results. But it will very rarely be required if a gag of proper size is provided. Such is easily obtained at the present day, with a little trouble.

Severity of the Case and Kind of Patient.—It is not so much the extent of the fissure—whether the soft palate is alone affected, partially or completely, whether that common form in which the cleft involves the soft and a portion of the hard is present, or whether the whole part is split—that is of importance, as the width of the cleft and the thickness of the tissues which bound it. Sir W. Fergusson was, I believe, the first who pointed out the influence which the height of the vault of the hard palate has upon an operation for closing a cleft of it. He showed that the higher the vault the more easy is it to dissect down flaps of muco-periosteum; while, on the other hand, the less arched the vault, the greater is the difficulty in getting sufficient flaps. Other points of

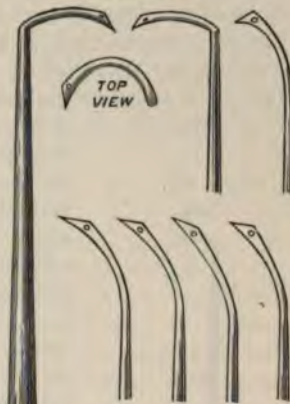
importance are the size of the mouth, a very narrow or small one interfering with the use of the needful instruments; and, finally (a point always to be noted), the length of the palate, for the shorter this is, the more impossible will it be for this to touch the pharynx later on, however perfectly it has been united, and the more marked, consequently, will be the nasal tone of the voice.

Other points of importance, but not connected especially with the cleft, are those which bear upon the general health of the patient—viz., fretfulness, or a sunny temper; greediness, as likely to cause bolting of surreptitious food; coexisting ear disease, or congenital syphilis; whether the child has had the usual illnesses and exanthemata—an attack of whooping-cough, scarlet fever, mumps, or measles interfering much with the result of an operation.

Amount to be closed at One Sitting, and Order of Operation on the Palate.—Where the cleft involves both palates, that through the soft is usually taken first, the severer operation being left till later. As to the amount which should be attempted at the first sitting, each case must be decided by itself, according to the experience of the operator, the severity of the case, and the safety with which the anæsthetic is taken. Sir T. Smith, one of our highest authorities, recommends* that the whole cleft should be closed at one sitting, "unless there are circumstances of peculiar difficulty in the case. When the bringing together of the whole cleft in one operation would necessitate so free a division of the soft parts as to endanger the vitality of the flaps, it is advisable to close first that part of the cleft that can be most easily approximated, whether it be the hard or the soft palate."

I should have unhesitatingly advised the surgeon, in his earlier operations, only to attempt to close those parts which come readily together (*vide supra*, p. 548). Any more than can thus be closed will only be so at the expense of a good deal of tension, and after much difficulty and a varying degree of bruising, &c.

FIG. 211.



Durham's needles of different patterns.

FIG. 212.



Cleft palate needle, tubular.

* *Dict of Surg.*, art. "Cleft Palate."

Mr. Berry's words (*loc. supra cit.*) emphatically support this advice: "If there has been much difficulty in getting the edges of the soft palate together, it is better to leave the anterior part of the hard palate to be closed by a subsequent operation—which can always be done if the posterior part has been closed—rather than to run the risk of spoiling the whole operation by endangering the vitality of the flap. It cannot, in my opinion, be too strongly insisted upon that for the purposes of good articulation it is essential that the soft palate should be well formed. It is far better to make at the first operation a good

soft palate than a good hard palate. A hole in the hard palate can always be closed unless extensive sloughing has occurred. It may, on the other hand, be extremely difficult to make a good and efficient soft palate, if the first operation has been followed by a faulty union of this part." Adenoids or enlarged tonsils should be removed several weeks before, any mucopurulent nasal discharge as thoroughly dealt with as possible, and the presence of carious teeth must be attended to as possible sources of infection, and to ensure stability for the gag.

Operations on the Soft Palate.—The instruments which would be required for closing a complete cleft of the palate may be enumerated here once for all. One double-edged and one blunt-pointed knife (like a large tenotomy-knife on a long handle), one pair of dissecting-forceps, and one with fine tenaculum or mouse-tooth ends, several needles of different patterns with eyes at the point, or a supply of small needles of different curves, to be used with a holder, a stout aneurysm-needle, four raspatories of varying curve and strength,* a pair of curved scissors (with a $\frac{1}{2}$ -inch curve) for detaching the soft palate from the hard, one of Sir T. Smith's gags,† which has previously been found to fit the patient, and sponge-holders. In addition to the above, a tubular needle with a reel for passing wire, and a wire-twister, will be found useful.

Cleft palate needle.
Durham's double curve.

The patient's stomach being just empty, so that he shall not vomit during the operation, nor want food immediately after, he is placed on a suitable narrow table, and in a good light. As soon as he is well under the anæsthetic (A. C. E. or chloroform), his hands and arms are secured in a jack-towel, one being always left within reach of the anæsthetist.

* If the cleft encroach at all upon the back of the hard palate, and in cases where the soft is alone affected and the cleft a wide one, some raising of the mucoperiosteum and separation of the soft parts at the junction of the hard and soft palates (p. 557) will be needed to avoid tension of the flaps.

† Those usually sold are much too large and clumsy. A choice of three sizes should be at hand, and the most fitting one selected beforehand. Whitehead's modification of the above gag is a useful one.

FIG. 213.



Then either the head and shoulders are suitably propped up with firm pillows, or, as I much prefer, the head is dropped at a right angle to the spine, over the end of the table, where it is supported by a sitting assistant. This method, which we owe to Rose, of Berlin, has the great advantages of giving thorough exposure of the parts now well under the surgeon's control, and of allowing the blood to collect in the upper naso-pharynx. The congestion of the parts which sometimes follows is usually temporary. Sir T. Smith's gag is next introduced, the tongue tucked under the central plate, and the jaws widely opened. The gag, which it is well not to tie, is then held by an assistant, who at the same time supports the head and moves it to suit the operator. Another assistant hands instruments and gives other help, while sponges are wrung out and supplied on holders by a nurse. Two points require attention at this stage: (1) The gag should be satisfactorily adjusted once for all. In fitting the tongue-piece, care should be taken that the base of the tongue is not jammed over the entrance of the larynx. It is a help, sometimes, to draw the tongue forwards and to one side with forceps or a silk loop. (2) Before commencing the operation the surgeon should assure himself not only that the breathing is regular, but also that the patient is *deeply* under the influence of the anæsthetic, without abolition of the laryngeal reflex. If this point be secured, without any hurrying at this stage, the subsequent interruptions for the administration of further anæsthetic will be few and brief.

The edges of the cleft are first pared in the following way—viz., by holding in the tenaculum-forceps the tip of one-half of the uvula, thus making the soft palate tense, and then transfixing the centre of each cleft alternately with a double-edged tenotome, cutting first up and then down. In either case the whole of each side should be made raw, and with as wide a surface as possible; it is the anterior angle and the tip of the uvula which are liable to remain unrefreshed. As far as possible this should be the only occasion on which the flaps are touched with the forceps.

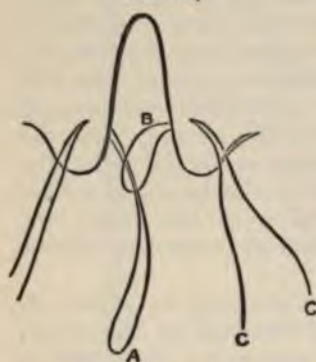
The sutures may be made of wire (without kinks), salmon-gut, and horsehair. Of these Sir T. Smith prefers wire for the hard palate and for any part of the soft in front of the uvula, preferring horsehair for the uvula itself.

Each surgeon will, in difficult cases, find advantage from being used to certain sutures. If the operator have tubular needles, and if both sides of the cleft can be spanned at once, he will find it very easy to work with silver wire. Salmon-gut and horsehair seem to me to be the least irritating next to wire, and very easy to work with after being softened by boiling. Silk, however carefully sterilised it may be at first, is always liable to cause suppuration and ulceration along the tracks of the sutures, and to necessitate their removal before the line of union is sound. Wire, salmon-gut, and horsehair may, if not tied too tightly, be left for an indefinite time.

The following methods will be found useful, according to the width of the cleft, and the needles used: (1) If a tubular needle be at hand, silver wire can be passed with great facility, if the cleft be a narrow one, save in the case of the uvula, for which horsehair should be used. If the cleft be a wide one, the sutures may be passed in one of the

following ways: (2) A slightly curved needle in a handle is passed through the edge on one side into the cleft; it is then threaded with wire and withdrawn, the wire is disengaged, the needle passed similarly through the other side, and threaded with the end already passed; this is then drawn through the second side by removing the needle, the wire being thus brought across the gap. I owe my knowledge of this, Mr. Hardie's very simple method, to an old friend, G. A. Wright. (3) Here the sutures are passed with small semicircular needles on a Hagedorn's holder or in Spencer Wells's forceps. The flaps having been pared, the tip of the right half of the uvula is lightly held with forceps, and a fine semicircular needle, threaded with the finest silk-worm-gut, is passed from before backwards through its base and

FIG. 214.



Loop-method of passing sutures.
(Mason.)

brought out into the cleft; the needle is released from the holder and drawn through. It is then readjusted in the holder, the tip of the left half of the uvula is similarly held on the stretch, and the needle passed again into the cleft and brought out from behind forwards, transfixing the left half of the uvula. After two or three sutures have been introduced in this way, the flaps, if sufficiently separated, can be held so close together by drawing gently on them, that the remaining sutures can be passed right across both flaps (C. P. Childe, *Brit. Med. Journ.*, July 4, 1903, p. 16).

(4) Fishing-gut or horsehair is introduced by pushing a loop through one side by an almost straight nævus-needle, and withdrawing it through the opposite side by a similar needle which has a suitable slot in it, instead of an eye (Clutton).

(5) Aveling's: A double loop of suture (while this is much more easily done with silk the objections to this material must be remembered) is passed on one side, and the loop drawn out of the mouth and held by an assistant; a single suture is then passed through the other side at a point opposite to this, and the end also drawn out of the mouth: this single suture is then looped into the double one, and by pulling this latter back the single one is drawn across the cleft. (6) Fergusson's method: Here it is intended that the silk threads passed should be carriers of silver wire, which is to constitute the permanent sutures. The obvious objection to this method is that so much material traverses the delicate flaps. One of the needles shown in Fig. 211, threaded with medium-sized sterilised silk about sixteen inches long, is passed through the oral aspect of the flap, sufficiently far from its margin to give good holding, and to allow for paring, if this has not been done already. The loop of silk (A) is next seized by forceps, introduced within the cleft, the needle withdrawn, and the loop pulled forward sufficiently to be laid on gauze on the face, where an assistant takes charge of it. The same thing is then done at an exactly corresponding point on the opposite side. By loosely threading the one to his left through the one to his right (B, C, C), and gently pulling on the latter, the surgeon safely carries the former through the flap that lies to his right side (Fig. 214). He then takes a piece of silver wire of suitable size, about six inches long, and doubling half an inch of this into a hook over the loop, by gently pulling on the free ends of the loop he draws the wire into place across the cleft.

The second, third, and fourth methods are the easiest of all, and will meet all cases. In using the second, in which the needle is passed unthreaded, it is a great help, as one of the surgeon's hands is engaged holding the needle *in situ*, and the other perhaps in sponging, if an assistant or nurse kneel on a pillow at his right side, and, having both hands (cleansed) disengaged, thread the needle.

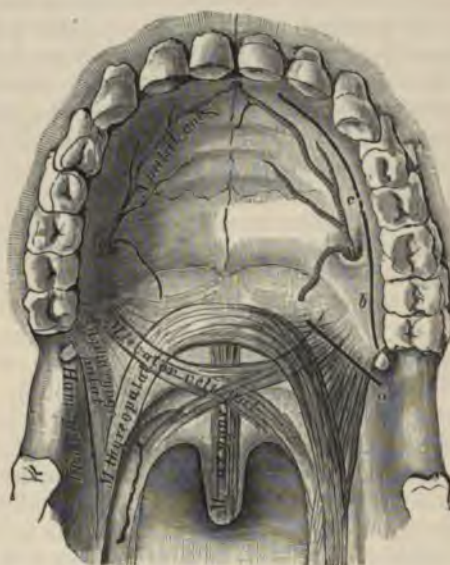
After the first suture is passed through the halves of the uvula, it should be used to make the edges tense, thus doing away with any need for the forceps. Attention should be paid to inserting the sutures at a sufficient distance from the edge and a due distance from each other so as to equally distribute amongst themselves any tension that may be present. In passing a suture, the needle point should be quickly stabbed through at the intended spot. When sufficient sutures have been passed, two or three should be tied (the wire being twisted with the fingers, with a twister or torsion-forceps), the gut and horsehair requiring a third knot. Then, if there is too much tension on the rest, longitudinal incisions may be made on each side of, and parallel to, the cleft. The length of these relieving incisions must vary; they usually begin on a level with the highest stitch in the soft palate, and run backwards close to the teeth in front, to end posteriorly at the junction of the soft palate with the lateral wall of the pharynx. Both pillars of the fauces should, in those cases which really require it, be divided with scissors low down. This not only relieves tension, but allows the palate to be drawn up to a higher level. "This is an immense advantage for the improvement of the voice" (Clutton). The bleeding from the incisions of relief will be severe, but yields to pressure applied firmly, and all tension is thus relieved. Throughout the operation the bleeding must be arrested by the surgeon himself, or by careful assistants making pressure firmly on the right spot with small aseptic sponges in holders. These should be wrung out of sterile saline solution by sterile hands. Sterilised adrenalin solution (1—1000) is very useful. Pressure duly and carefully applied may be relied upon to arrest the bleeding without damaging the flaps. There must be no unnecessary manipulation of these, and, above all, no bruising of them. Dabbing sponges about needlessly does no good as regards the hæmorrhage, while it is harmful in exciting exudation of mucus and injuring the soft parts. Any clots that may form should be deftly caught in a sponge with a turn of the wrist, and quickly removed. The more the surgeon himself does the sponging the better. He knows best how to do it; he sees best where it is required, and his looking to it himself will save additional hands in an already confined space. Sponges on holders should be handed to him, singly, by an assistant who is kept supplied with them by a nurse. If the blood, in spite of the above precautions, collect in the pharynx and nose, the child should be turned right over, the head held by the hair, and the blood allowed to run out into a basin on the floor. If much blood get into the stomach, it is a certain emetic.

The after-treatment and the causes of failure are given a little later at pp. 574, 575.

Operation on the Hard Palate.—An incision (Fig. 215) is made on each side down to the bone with a small stout scalpel, from a point a little anterior to the apex of the cleft, immediately behind the lateral

incisor, parallel with the alveolar margin, back to one opposite to and just internal to the last molar tooth, and reaching from the anterior edge of the cleft to the posterior edge of the hard palate.* Through this incision raspatories of suitable length and curve, or blunt-pointed scissors curved on the flat, are introduced next to the bone and pushed inwards till their points appear in the cleft. By movements from without inwards antero-posteriorly and *vice versa*, the mucous membrane and periosteum are separated from the bone, every possible care being taken

FIG. 215.



The chief parts concerned in the operation for cleft palate, the lateral incision *b, c* through the mucous membrane, and that for division of the muscles, *a*, are shown (v. Esmarch and Kowalzig). The last incision is largely replaced on the Continent by detaching the hamular process after Billroth's method. The chisel is introduced upwards and inwards, and the dislocation of the process completed with an elevator.

to raise these of even thickness and without laceration or button-holing.

* A word of caution is needed here and with regard to Fig. 215. On the one hand the lateral incisions must be free enough to allow of the easy separation of the muco-periosteal flap by sweeps of the elevator not only from within outwards but also from before backwards and from behind forwards. On the other hand the operator must be careful to leave in front and behind pedicles sufficiently broad for the nutrition of his flaps. The lateral incision in Fig. 215 errs in the respect of too great freedom. If in addition one were also made for division of the muscles (a step very rarely required when the separation of the flaps by the elevator in the directions indicated above has been really adequate), sloughing of the flaps might easily follow. Mr. Berry (*loc. sup. cit.*) lays stress on limiting these incisions. It is seldom necessary to carry them farther forwards than the first or second premolar tooth in young children or the first or second molar in those who have cut these teeth." Posteriorly the lateral incisions should reach to the junction of the soft palate with the lateral wall of the pharynx.

The chief difficulty will be met with at the two ends of the bony cleft. If the anterior extremity of the gap reaches as far as a point just behind the incisors, much difficulty will be met with in separating the muco-periosteum here, and the surgeon will do well to be provided with two or three small raspatories of different curves. Mr. Berry advises, where there has been much difficulty in getting the edges of the soft palate together, "it is better to leave the anterior part of the hard palate to be closed by a subsequent operation—which can always be done if the posterior part has been closed—rather than to run the risk of spoiling the whole operation by endangering the vitality of the flaps." In those cases where the septum nasi is attached to one side of the cleft the bringing down of a flap from this may help in closing the front part of the cleft. Again, at the junction of the hard and soft palates, the soft parts are firmly bound down to the former by fibrous tissue. To free them the raspatory should be pushed into the cleft at the junction of the oral and nasal mucous membrane, and carefully but thoroughly moved from side to side so as to free the palate here completely. A pair of angular scissors may also be used, one blade being placed under the muco-periosteum, between it and the bone, and the other passed through the cleft, above the soft palate, the fibrous tissue being thus divided close to the bony palate. A third spot but a less important one where difficulty may be experienced, is the attachment of the soft parts in the neighbourhood of the hamular process. Here a curved raspatory, a blunt-pointed narrow curved bistoury, or curved scissors—each being kept close to the bone—must be thoroughly used. As Mr. Rose advises, the introduction of the left forefinger into the incision is of great assistance in effecting the separation here and at the back of the hard palate with precision and thoroughness. *The thorough separation of the soft parts, especially at the junction of the hard and soft palate, by relieving all tension on the sutures, and by doing away, probably, with the need of prolonging backwards the lateral incisions, is the key of the operation.*

With regard to the date at which the flaps are pared, many surgeons do this at the beginning of the operation, as it facilitates the free use of the raspatory in raising the muco-periosteum from without inwards. Mr. Rose, on the other hand, advises that the paring be postponed until the flaps have been detached, as the raw edges are thus less liable to be bruised by the sponges, and with the flaps loosened the margins can be pared with greater accuracy. I recommend that his advice be followed.

While the soft parts are thus separated the hæmorrhage will be free, but always yields to the steps advised at pp. 555 and 575.

Tension may in part be removed by prolonging the lateral incisions backwards, when this step is really needful.

When all bleeding has stopped, the lateral incisions and any made in the pillars of the fauces are brushed over with pure carbolic acid. Packing of these with gauze is, in my opinion unnecessary to prevent hæmorrhage. Owing to the difficulty of keeping it in place it is unreliable as a support for the flaps. The sutures are then inserted as before (p. 553), wire or salmon-gut being used here.

Sir T. Smith points out that, in bringing together the halves of the palate, care must be taken to evert the edges of the cleft with a small double hook in passing and securing the sutures.

In those cases where I have been dissatisfied as to the complete removal of tension on the flaps I have passed a stout silver wire suture by means of an aneurysm-needle with a large curve around both flaps through the lateral incisions, and twisted it up. C. M. Mayo has made use of a tape passed in the same way, it is drawn first tight enough to keep the flaps together. The ends are not knotted but secured by a silk ligature. The ends of the tape are cut short when thus secured and slid round on to the nasal surface of the flaps. It is removed about the seventh day. This device does not appear to cause infection and is spoken highly of by some American surgeons, *e.g.*, Dr. C. H. Peck, of New York, *Ann. Surg.* Jan. 1906, p. 5, a very practical paper.

Sir W. Fergusson's Method (Figs. 216 and 217).—This surgeon, finding that even in his hands attempts to completely close the hard palate often failed owing to the contraction of granulations, by which the lateral flaps were drawn back to their original position, introduced the following modification, which he especially recommended for apertures in the hard palate, but which he had used with great success in a complete cleft of both.

Sir W. Fergusson, having pared the edges, divided the palate, both soft tissues and bone, first with a scalpel and then with a chisel,* about a quarter of an inch from the

FIG. 216.

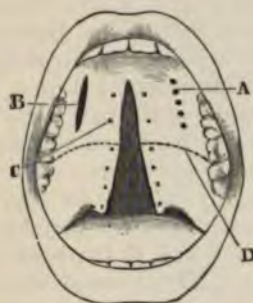


FIG. 217.



- A, Preliminary punctures with the bradawl to give line for the chisel.
- B, Incisions through the bone completed by the chisel.
- C, Holes in the palate for the sutures.
- D, Junction of the hard and soft palate.
- E, Lateral openings subsequently filled up by granulations. (Bryant.)

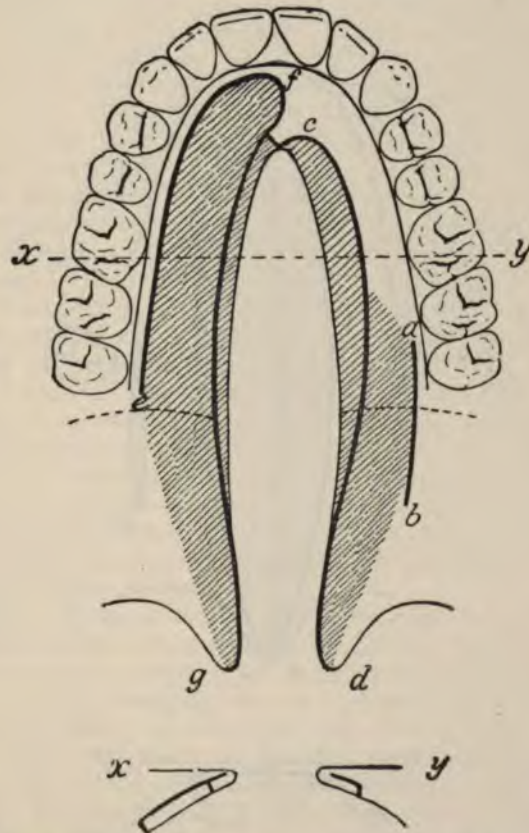
margin of the gap on each side. With the chisel pushed up into the nose through each incision, by slight movements from side to side, each lateral portion was prised towards the other until they met in the middle line, when sutures were inserted between the pared edges of the soft parts. In some cases sutures were inserted not merely into these edges, but were passed through the lateral apertures right across the gap. Haemorrhage was arrested by plugging the lateral incisions, if needful. Nowadays aseptic gauze is best used for this purpose. Sir W. Fergusson stated his belief that the objections which at first arise to his method are not valid—(1) There is no caries or necrosis; (2) there is no dangerous haemorrhage; (3) there is less risk of sloughing than by the old method; (4) the lateral incisions heal well. He admitted that if, as sometimes occurs, the vomer was found attached by its lower margin to the palate, it would be difficult to introduce stitches. But approximation alone of the edges would probably convert the gap into a mere chink, imperceptible to ordinary observation. Other surgeons have, however, found that this operation is certainly attended with the above disadvantages, and that the haemorrhage and sloughing may be followed by septicæmia in weakly children, and in a region like this which cannot be kept aseptic. It is noteworthy that Mr. Rose, who was

* Preceded in some cases by drilling a line with a bradawl, as in Fig. 216, drawn by Mr. Rose for Mr. Bryant's *Surgery*, vol. i. Figs. 184, 185.

one of Sir William's assistants, does not recommend the operation. I consider it a much severer operation than that usually performed, and only to be resorted to in the case of very wide clefts, or where a previous operation has failed.

Mr. Davies-Colley's Flap Method for Hard Palate (Figs. 218 to 220). This was first published by its inventor in the *Brit. Med. Journ.*, Oct. 25, 1890, and recommended as applicable (1) in infants; (2) in cases where the ordinary operation had failed; and (3) in cases in

FIG. 218.



The shading indicates, in the hard palate, stripped-up periosteum; in the soft palate, the stripping into two planes. The lower figure represents diagrammatically a transverse vertical section through the hard palate along the line *x y*.

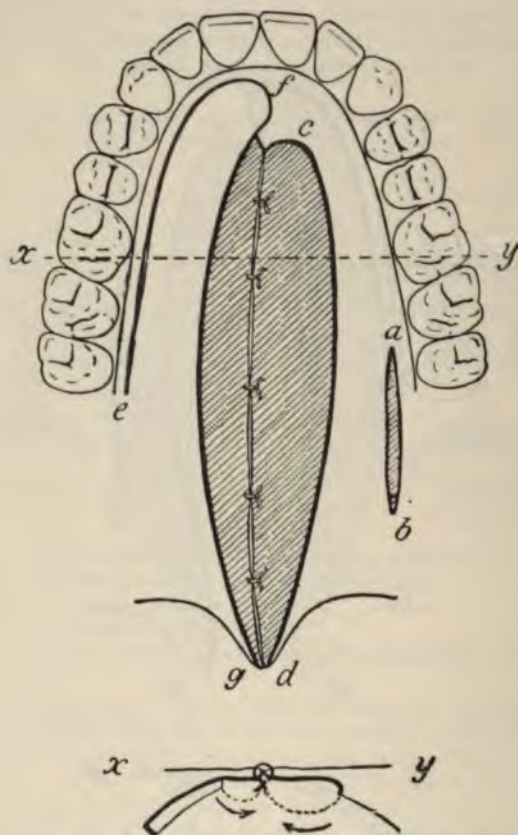
which the cleft of the hard palate was too wide to be bridged over by the ordinary operation. The late Mr. Davies-Colley afterwards published his method in a modified and extended form (*Trans. Med.-Chir. Soc.*, 1894, vol. lxxvii. p. 236). It may be divided into the three following stages:—

*“First Stage: that of Incision and Separation of the Muco-periosteum (Fig. 218).—*The patient being under an anæsthetic, and the jaws held open by a Smith's gag—(a) an incision, *a b*, is made from before

backwards, about an inch long, with its centre just internal to the last molar tooth. It should go down to the bone in front, and behind it should pierce the soft palate. Through this incision a raspatory is introduced, and the soft parts separated inwards from the posterior half of the hard palate, much as in the ordinary operation, but not to such an extent.

“(β) An incision, *c d*, is carried on the same side from just in front

FIG. 219.



The lower part of the diagram represents a similar section to that shown in the preceding figure. The arrows indicate the direction in which the muco-periosteum of the margins of the cleft is reflected inwards.

of the cleft, and at a distance of about a quarter of an inch from its margin, backwards to the junction of the hard and soft palate. As it approaches the soft palate the incision should converge to the edge of the cleft, and it should be continued along the edge of the soft palate in such a way as to split that structure to the depth of about three-eighths of an inch. For this purpose the knife should be lateralised, and as the knife approaches the uvula a forceps will be required to hold the uvula steady while it is being divided. At this part the incision

must be not quite so deep, in order to avoid the complete division of the lateral half of the uvula. The soft palate near the cleft will now consist of two planes—a lower one which is continuous with the band of muco-periosteum between the two incisions, *a b* and *c d*, and an upper one attached to the back of the hard palate. The muco-periosteum internal to the incision *c d* should be separated *inwards* from the bone until it is left attached by the soft tissue which covers the margin of the cleft of the hard palate.

“(γ) A large flap, *e f g*, of somewhat triangular shape, but with the front angle rounded, should be taken from the other side of the palate. One side of the flap, *e f*, runs parallel to and a sixth of an inch from the insertions of the teeth from the last molar to the median incisor; the other, *f g*, runs backwards at a distance of a sixth of an inch from the margin of the cleft of the hard palate, and continuous with a splitting of the soft palate similar to that upon the other side, and reaching as far back as the tip of the uvula. The muco-periosteum of the triangular flap should also be separated from the hard palate by means of the raspator, and, finally, that which lies internal to *f g* should be separated *inwards*, until it is only attached to the margin of the cleft.

“*Second Stage: the Union of the Mesial Flaps and the Upper Planes of the Soft Palate* (Fig. 219).—By means of an ordinary palate-needle, with the curve at the end in a plane at right angles to the stem, five sutures of silk or catgut are passed through the edges of the flaps internal to *c d* and *f g*, care being taken to turn the flaps *inwards* so that their mucous covering looks upwards and their raw surface downwards. Continuously with this union the edges of the upper plane of the soft palate on either side must be brought together in the same way. From four to six sutures are necessary for this stage. When it is completed the whole cleft of the hard and soft palate should be bridged over by a layer of muco-periosteum and soft palate tissue, with the raw surface looking downwards.

“*Third Stage: Union of the Triangular Flap and the Lower Planes of the Soft Palate* (Figs. 219, 220).—With the same needle, sutures of soft silver wire are now passed in the ordinary way so as to draw over the margin, *f g*, of the triangular flap to the outer edge of the incision *c d*, on the other side. At the same time the margins of the lower planes of the split soft palate are brought together in the same way. About six wire sutures are necessary, and two silk or horsehair sutures may be used for the approximation of the uvula and the adjacent parts of the soft palate. There will now be a second complete bridge across the cleft, but in this bridge the mucous surface will look downwards, while the raw surface will look upwards and be in contact with the raw surface of the first bridge. The incision *a b* gapes widely, and may have to be increased in size, especially at the expense of the muscular tissue of the soft palate, in order to allow the edges to come together without tension.

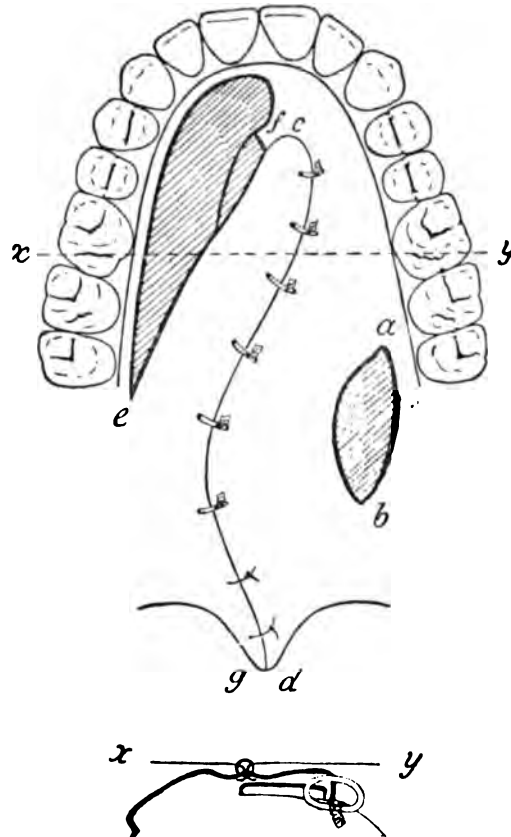
“The *after-treatment* is similar to that which is usual after the ordinary operation. I have generally allowed an interval of at least three weeks, and sometimes as many as six weeks, before removing the sutures of the third stage, while those of the second stage have to be left to come away as they can, or to be absorbed.

“There is so little tension, that if primary union should fail,

secondary union would probably take its place. For a short time a raw surface is left in the opening made by the gaping of the incision *ab*, and on the other side over the space previously covered by the triangular flap; but these surfaces soon get covered with granulations, and give rise to no trouble or deformity."

The chief advantages claimed for this operation are—(1) No tissue

FIG. 220.



The lower part of the diagram represents the same section as that shown in the two preceding figures.

has to be pared away. (2) A much larger extent of raw surface is brought into close contact than by the ordinary operation. (3) The tension, at any rate in the lower bridge uniting the sides of the hard palate, is much less. (4) Whereas, in the ordinary operation, the pressure of the tongue tends to tear apart the slender line of raw surface which has to unite, in this operation the pressure is beneficial, as it keeps the raw surfaces of the two bridges in close contact.

The chief *disadvantage* is that the operation takes about half as long again as the ordinary operation, because of the number of sutures to be inserted. As to the danger of sloughing when so large a flap has been

so freely detached, the late Mr. Davies-Colley had never known this to occur. Speaking at a meeting of the Medical Society (*Trans.*, 1896, p. 70),* Mr. Davies-Colley said that his more recent experience, since reading his paper eighteen months before at the Medico-Chirurgical Society, had been three cases of complete cleft between fourteen and eighteen months of age. In two he had succeeded in obtaining complete union of the hard, and considerable, though not complete, union of the soft palate. He repudiated the idea of wishing to adopt the flap operation in every case. Of six cases which he had had in the last six months, four had been done by the ordinary method, but he did not employ this method in the case of young children, because the flap operation was so much more certain in its effect.

Flap Method of Mr. W. A. Lane.—Mr. Lane (*Cleft Palate and Hare-Lip*, 1905, p. 42; *Clin. Lect.* p. 15) considers that "The best time for operation is the day after birth, or as soon after that as possible.

FIG. 221.



Mr. Lane's needles and needle-holder.

The newly-born child is always healthy, the capacity of its tissues for repair being at the very best, its digestion has not been impaired by experimental and usually most unsatisfactory feeding, and its resisting power reduced correspondingly; it is apparently uninfluenced by the operation in that it does not cry or show evidences of being in pain; it is never or hardly ever sick after the anæsthetic, but takes its food within an hour or two of the completion of the operation with apparent enjoyment; the loss of blood is very slight, being usually much less than in the case of a circumcision, and the risk to life is under ordinary conditions very trivial indeed."

"The general principle on which most of the operations are based is that of raising from the roof of the mouth on one side of the cleft, a flap, which consists of the mucous membrane, submucous tissue and periosteum of the roof of the mouth, and when this flap extends over the alveolus, care is taken to avoid unnecessary damage to the subjacent teeth. This can only be done efficiently very soon after birth. In early infancy it is possible to provide a well vascularised thick flap, which is practically three times as broad as can be obtained when the teeth have begun to encroach materially on the mucous membrane or

* Speaking to me in December, 1899, Mr. Davies-Colley stated that he had, latterly, been increasingly adopting the old operation.

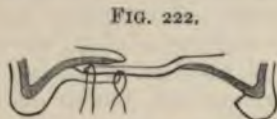
to perforate it, since the muco-periosteum covering the under and outer surface of the alveolus can be made to form the outer two-thirds of the flap.

"In performing the operation the child is placed under an anæsthetic, a thread is passed through the tip of the tongue by which traction can be efficiently exerted." Mr. Lane uses his toothed gags made in pairs.

Several sizes should be at hand. His needles and needle-holder are shown in Fig. 221. The first two of the curved needles are the most generally useful.

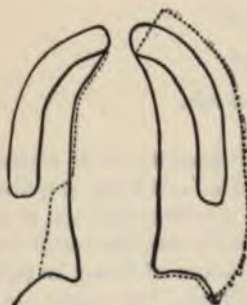
"The manner in which the flap is formed from the muco-periosteum on one side and is fixed beneath the separated muco-periosteum lining the roof of the mouth on the opposite side is of the cleft in an edentulous infant represented in Figs. 222, 223 and 224."

Showing the flap raised and fixed in position. In this case the cleft is not of sufficient breadth to render it necessary to strip the alveolus of its covering of mucous membrane. (Lane.)



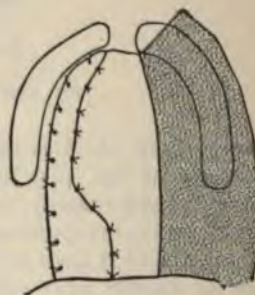
"In the soft palate, the flap which is raised comprises all the soft parts down to the tensor palati, and may be made as extensive as necessary by encroaching on the cheek if there is not enough material in the remains of the soft palate. On the other side of the cleft, the muco-periosteum is divided along its free margin till the soft palate is approached. The extremity of the uvula or its relic is picked up with

FIG. 223.



A cleft of a breadth sufficient to require the employment of a flap from the entire alveolus. The dotted lines indicate the incisions, that to the left of the cleft being on the nasal surface of the palate, while that on the right is on the buccal aspect. (Lane.)

FIG. 224.

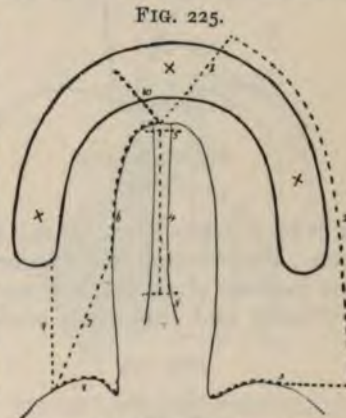


The flaps sutured in position. The shaded area represents the surface laid bare by the removal of the flap. (Lane.)

forceps, and an incision made outwards from it along the free margin of the palate for some distance, and from its outer limit another is carried forwards and inwards along the upper part of the soft palate to reach the posterior limit of the incision running along the free margin of the hard palate. The triangular flap of mucous membrane and submucous tissue intervening between the two incisions described and the margin of the cleft in the soft palate is raised off the subjacent muscles and turned inwards, and the raw surface left by doing so is increased in area by turning outwards a further portion of the mucous membrane covering

the soft palate externally. By this means the area of the upper surface of the soft palate, rendered bare by the removal of its mucous covering, is rendered much greater than before. By means of a stout steel elevator introduced between the muco-periosteum and the bone through the incision made along the margin of the cleft, the muco-periosteum is raised from the bone up to the inner margin of the alveolus. The flap, whose edge is attached along the margin of the cleft, is placed beneath the flap which has been raised from and for a considerable distance beyond the margin of the cleft, and it is pinned down by fine curved needles and 0000 Chinese twist silk in this position by a number of sutures which perforate the free margin of the reflected flap and the outer part of the elevated flap, the knots being tied on the under surface of the latter, whence they can be removed with facility when the opposing surfaces have united firmly, which they do in about ten days. Then the free margin of the raised flap is attached by separate sutures to the raw surface of the reflected flap. Finally, the opposing edges of the free margin of the soft palate are united in a similar manner."

"In Fig. 225 I have attempted to indicate diagrammatically the details of the method I have described. It is intended to represent the roof of the mouth of an infant, showing a broad cleft involving almost the entire palate. The position of the alveolus is indicated by the three crosses, **xxx**. 1 represents the incision which extends forwards and outwards through the muco-periosteum from the anterior limit of the cleft, and which passes over and beyond the alveolus to its outer surface; while 2 commences at



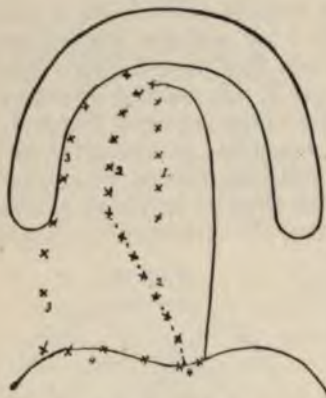
Incisions and flaps for broad cleft.
(Lane.)

its outer limit and runs back along the outer surface of the gums about the junction of the cheek and alveolus. An incision 3 is then made from its posterior extremity along the free margin of the palate to the uvula. The flap included between these incisions is raised from the subjacent structures, a specially designed small knife, or a carefully constructed pair of sharp-pointed scissors, being used for the purpose. As the posterior palatine foramen is approached, an elevator pressed in between the flap and the bony palate causes the posterior palatine vessels and nerves to protrude for a considerable length in a tube of periosteum. This is readily grasped by a pair of efficient compression forceps and divided beyond.

"It happens not uncommonly in the type of cleft palate illustrated by Fig. 225 that the septum presents a free margin which extends almost, if not quite, to the level of the cleft. In these cases I make an incision (4) through the mucous membrane and periosteum or perichondrium along the middle line of the septum with two small transverse incisions (5) at either end, and turn down laterally the narrow flaps so formed, leaving the cartilage or bone bared and exposed. By placing the flap which has been raised, in position, the line along which it will rest on

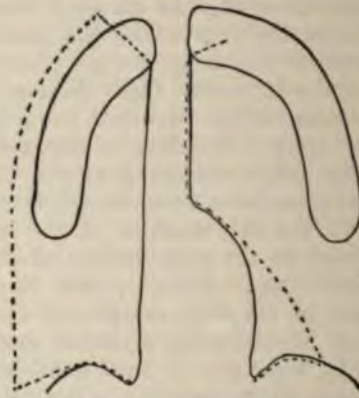
the septal margin can be readily defined. With a sharp knife the surface of the reflected flap is denuded of its covering of mucous membrane along the area of impact. By a series of sutures perforating the superjacent impaired flap and the margin of the septum

FIG. 226.



Flaps in position.
(Lane.)

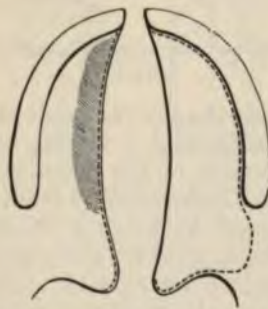
FIG. 227.



Flaps for a common type of cleft palate
(Lane.)

if it be not too hard, or the flaps of muco-periosteum if the edge be bony, the reflected flap is pinned to the septum. 6 in Fig. 225 shows the incision along the free margin of the cleft continued as 7, obliquely outwards and backwards along the upper surface of the soft palate.

FIG. 228.



A complete cleft of the palate. The dotted lines indicate the incisions, and the shaded area the portion of muco-periosteum elevated from the subjacent bone. (Lane.)

FIG. 229.



The flap fixed in position by a double row of sutures. The shaded part shows the surface of hard palate stripped of muco-periosteum. (Lane.)

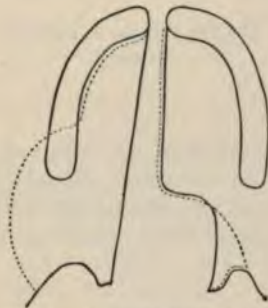
The incision 8 extends from the posterior limit of 7 along the lower free margin of the soft palate to the tip of the uvula, and the incision 10 forwards and outwards from the anterior limit of 6 on to the alveolus. This last incision facilitates the raising of the flap on this side, and of the introduction beneath it of the reflected flap from the opposite side. After the muco-periosteum external to the incision 6

has been raised from the bone, the soft palate is freed from the posterior margin of the hard palate, and the mucous membrane on its upper surface turned outwards to the position of 9.

"In Fig. 226 the flaps are shown in position. The sutures along the line 1 represent those attaching the septum to the reflected flap. Those along 2 show the sutures which unite the free edge of the raised flap to the under surface of the reflected flap; those along the line 3 anchor the edge of the reflected flap, and those along the line 4 connect the flaps where they form the free margin of the new soft palate."

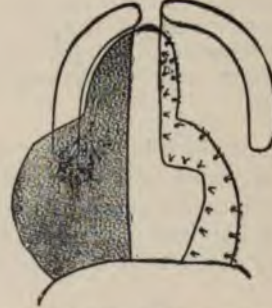
"Another common type of cleft palate is that illustrated in Fig. 227, the cleft in front being to one side of the middle line extending from between the septum and a portion of the roof of the mouth, while posteriorly the cleft in the soft palate is fairly symmetrical. As the mucous membrane is always very thin where it covers the septum and the adjacent portion of the roof, the flap must be reflected inwards

FIG. 230.



A common form of cleft. The dotted lines on the nasal aspect to the right of the cleft and on the buccal aspect to the left of the cleft indicate useful incisions. (Lane.)

FIG. 231.



The flaps in Fig. 230 in position and sutured. (Lane.)

from the narrow or less developed side and raised outwards from the septum, the narrower flap being fixed beneath the muco-periosteum covering the broader side of the roof of the mouth."

"Figs. 228, 229, 230 and 231 show the form of flaps when the teeth have come through the gum, or when a sufficient flap can be obtained without encroaching on the gum, and Figs. 222 and 233, the manner in which the cleft in the soft palate is closed. Associated with a complete cleft of the palate there is often a displacement forwards of the pre-maxilla, which is attached to the under surface of the septum beneath the tip of the nose. I have found it best to divide the mucous membrane along the limits of the pre-maxilla, laterally and posteriorly avoiding any interference with the soft parts in front. The muco-periosteum is separated from the subjacent pre-maxilla and is reflected forwards. The pre-maxilla is cut away from the septum by means of biting forceps, the edge of the septum being nicely trimmed and rounded. This flap, which consists of a mesial relic of lip and muco-periosteum, is opened out when it covers a considerable area. Its

margin is attached by sutures to the raw under surface of the reflected flap, and to the raised flap, which is rendered raw where the pre-maxillary flap covers it by the removal of its epithelial covering by means of a sharp knife. In this way the gap between the alveolar

FIG. 232.



The dotted line to the right of the cleft represents the incision along the buccal aspect of the palate, and that to the left the incision along the pharyngeal aspect. (Lane.)

FIG. 233.

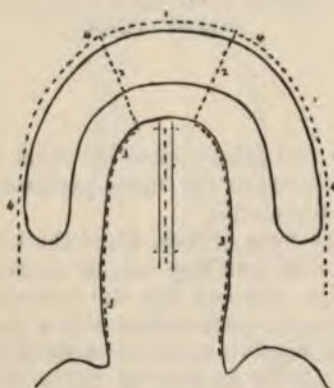


The flap sutured in position. (Lane.)

segments is filled up very advantageously, and later, when the cleft in the lip is closed, the mesial relic of the lip serves to complete the septum and to afford attachment to the lateral margins of the cleft."

"It happens not infrequently that it is impossible to close the whole length of the cleft by one single operation.

FIG. 234.



Flaps for a very wide cleft. (Lane.)

FIG. 235.



Flaps in Fig. 234 in position. (Lane.)

"Fig. 234 illustrates such a condition. The cleft is a very wide one, and it is impossible to close it by the reflection of flaps in the manner described. An incision is made along the entire outer aspect of the gum along the line indicated by 1. Two are made along the direction of 2, and two others along the free inner margins of the cleft. The

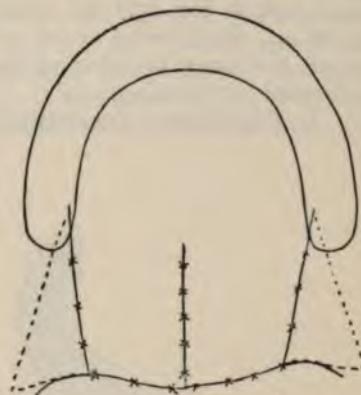
flap included between 1 and 2 on either side is turned back, great care being taken of its attachment, which is usually very thin. The flaps comprised between 1, 2 and 3 are raised from before backward, care being taken to avoid any damage to the descending palatine vessels. These flaps are then displaced inwards, as in Fig. 235 their opposing

FIG. 236.



Flaps for closure of back of cleft.
(Lane.)

FIG. 237.



Flaps in Fig. 236 in position.
(Lane.)

margins being sutured together and to the subjacent flap, and if possible to the septum also."

"At a later period the posterior portion of the cleft may be closed in one of two ways, the method varying with the breadth of the cleft and the extent of material at disposal. The first and more generally

FIG. 238.

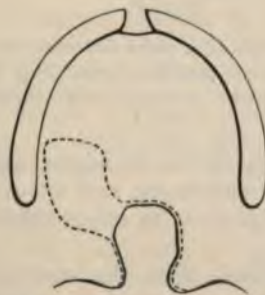


FIG. 239.



One of Mr. Lane's methods for closing a residual cleft in the soft palate.

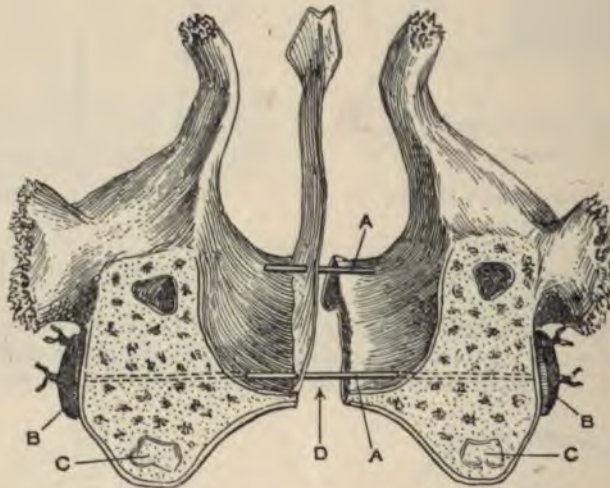
applicable method is by reflecting a flap inwards on one side, leaving it attached by its inner margin, the other flap being rendered raw on its posterior surface and its area extended as in Figs. 232 and 233. The second method is to reflect a flap inwards as before, while the flap from the opposite side is reflected from the subjacent parts by an incision extending along the outer margins, so that it pivots anteriorly as to cover the flap reflected

from the opposite side. Or both flaps may be made to pivot upon their anterior attachments, their internal edges are sutured carefully together, the outer free margins being anchored wherever a suitable attachment can be found. The free inner margins of the cleft are also pinned down to the superjacent flaps by sutures."

"In Fig. 236 I have indicated the mode of closure of the back of the cleft by raised flaps, the outlines of which are represented as dotted lines, and in Fig. 237 the suturing of the raised flaps on both sides in position. In order to avoid confusion, the knots of the sutures which attach the inner margins of the cleft to the superjacent flaps are not indicated in this diagram."

"In this diagram the outline of the flaps are represented as firm lines,

FIG. 240.



Vertical section of the superior maxillary bones of a child five weeks of age, showing congenital cleft palate. A, A, Silver wire tension-sutures. B, B, Lead plates. C, C, Germs of the first temporary molar teeth. D, Cleft palate. (Brophy.)

the dotted lines representing the position of the incisions, and show portions of the area deprived of mucous membrane, and uncovered by the flaps, which have been brought inwards so as to oppose their inner margins."

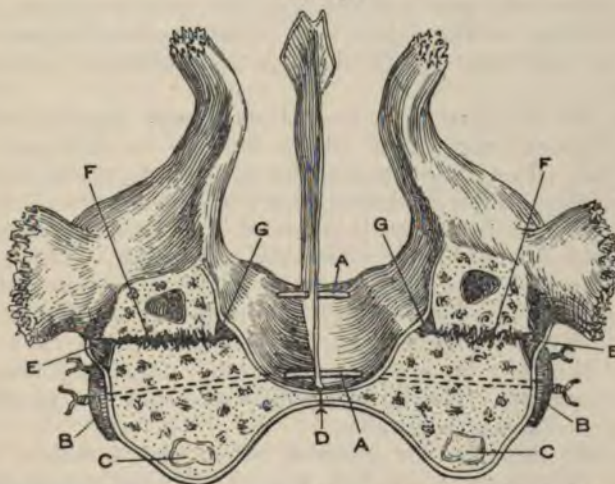
"As regards the treatment of the infant after the operation, no change whatever in diet is adopted, nor is any attempt made to sponge or spray the interior of the mouth. Means are taken to insure that the hands cannot be introduced into the mouth. At the end of about eight or ten days the stitches are removed. Should a cleft in the lip complicate that of the palate, the former is closed as soon as the palate has been dealt with, never before. In most cases I perform both operations under a single anæsthesia."

Brophy's Operation (Figs. 240 and 241).—Dr. Brophy, surgeon-dentist, of Chicago, operates on the palate first, and deals with the cleft by thrusting the maxillary and palate bones together. We owe

its introduction into this country to Mr. Owen. The following description of the operation is taken from his *Cleft Palate and Harelip*, p. 47, and Dr. Brophy's papers quoted below. The child operated on by Mr. Owen by this method was three months old, the cleft a broad one extending into the right nostril. The vomer was adherent to the left maxillary process.

"The operation was begun by paring the edges of the cleft, and after this I tried, but ineffectually, to thrust the maxillæ towards each other by firm pressure with the fingers and thumb. Next I raised the cheek, and, well back, towards the posterior extremity of the hard palate, just behind the malar process, and above the level of the horizontal process of the palate-bone, drove the end of a strong needle

FIG. 241.



Vertical section similar to that in Fig. 241, showing method of closing cleft of hard palate. A, A, Silver wire tension-sutures. B, B, Lead plates. C, C, Germs of first temporary molar teeth. D, Cleft closed. E, E, Muco-periosteum, forming external wall of the triangular space made by forcing the lower fragments of the bone inward. F, F, Lines of fracture made by approximation of the palatal processes. G, G, Triangular space on nasal surface of bone made by approximation of the palatal processes. (Brophy.)

on a handle through the substance of the maxilla. This needle carried a thick silk pilot-suture through to the cleft, where its loop was pulled down towards the mouth. Then the needle was similarly passed through the opposite maxilla, the loop being brought down as before. The second loop was passed through the first, which, being drawn upon, was made to bring the second loop through both of the maxillæ and across the nasal fossa, above the level of the hinder part of the alveolar processes. The sharply-bent end of a thick silver wire was then hooked on to this loop, and by pulling back the latter, the wire was made to take its place. The wire suture thus lay above the horizontal processes of the palate-bones, where it could pass through the cleft. Similarly, a wire suture was taken through the maxillæ above the front part of the cleft. Two small, triangular spaces, between the maxillæ and the palate-bones, were made by forcing the lower fragments of the bone inward.

with a hole drilled near each end, had already been prepared, and one of them was then laid along the outside of the right maxilla, under the cheek, the end of the hinder wire being passed through the posterior and the end of the front wire through the anterior hole. The right ends of the wire were then twisted together from left to right, the plate being closely applied against the maxillæ, after which the ends of the wire were pressed down flat. The ends of the wire under the left cheek were then similarly treated, and, as they were being twisted up, the maxillæ were squeezed together, or, rather, another vigorous attempt was made to squeeze them together. But I could not move them. So, in accordance with Dr. Brophy's method,* I then incised the mucous membrane over each malar process, and, introducing a scalpel, divided the maxillæ sufficiently to enable me to thrust their palatine processes into the middle line. After this it was at once seen that the width of the gap in the lip had been greatly reduced, and that the lateral halves of the palate were brought closer together. Fine wire sutures were then passed through the freshened borders of the entire cleft.

"When the maxillæ have been thus thrust together, the wires extending between the leaden plates have to be tightened up and again twisted. These wires and plates are not disturbed for three or four weeks. Some superficial ulceration sometimes takes place beneath the borders of the plates, but it is not of importance. The wires and plates may be removed after about the third week. The infant was very ill for two or three days, and the union of the sutured borders was only partial, but the front of the cleft was solidly closed, and a useful bridge held securely at the junction of the hard and soft palate." Ultimately the cleft was completely closed by four supplementary operations. The lip was dealt with about two months later. The whole result was admirable.

Dr. Brophy brought his method before the American Surgical Association (*Trans.* 1904, vol. xxii. p. 124). He laid stress on the need of operating before the third month, and of closing the lip a few months later. He considered that shock was less felt in infants than in those older, owing to their nervous system being less developed. He "placed the mortality at 3 per cent. in 300 cases in infants." In the discussion which followed, Dr. A. H. Ferguson, of Chicago, while recommending early operation—it should be completed before the child can talk—preferred his own flap-operation. In his own words: "The only two patients with cleft palate that I have lost were operated on after Brophy's method. They were under three months of age, and they died from shock. I consider the crushing of the maxillæ together a major operation in the case of an infant, and surgical experience bears out the fact that infants readily succumb to major operations." Dr. Ferguson also drew attention to the fact that

* Dr. Brophy's words on this point are: "If we are unable to close the fissure with these wires, if from lack of tissue or from firm resistance of the parts it cannot be done, there is a further method to be employed which will obviate these difficulties. With your knife, after the cheek is well raised, divide the mucous membrane just over the malar process. Here insert a knife in the horizontal direction dividing the bone freely, but damaging the mucous membrane as little as possible."

the upper jaws are normally broader than the lower, and when the crushing operation is performed marked irregularity of the teeth occurs, which he claimed to have been shown by the cases brought before the meeting. With this conclusion Dr. Brophy did not agree. Dr. J. E. Mears, of Philadelphia, also considered it a question whether Dr. Brophy's method was "as free from danger as other methods."

If, as claimed by Dr. Brophy, the mortality after his operation is very low, we shall, no doubt, hear shortly of numerous successful cases from the chief children's hospitals in London, where this method is being tried.

I would suggest to those who, in making use of this method in infants of about three months, find the bones fixed, and the severity of the manipulations needful to loosen them much increased, that it may be wiser, sometimes, to carry out Dr. Brophy's method in stages; thus, in the first, to loosen, and, if possible, to transfix and wire the bones together; and, in the second, to pare and unite the edges of the cleft.

Before any judgment approaching to finality can be passed on the advisability of widely adopting this method, we require the detailed results from a large number of cases. As far as I am aware, such have not been published. It is clear from common sense and Mr. Owen's case that shock and a low form of septicæmia will be the chief dangers. Since Mr. Owen introduced the operation to the notice of English surgeons, two opinions have been published with regard to the method. Sir Thornley Stoker (*Brit. Med. Journ.*, June 24, 1905, p. 1372) has published three cases, æt. 12, 9, and 6 weeks respectively. All three were severe cases, and in all there was an entire absence of shock or severe symptoms. The first case was entirely successful. On October 10, the malar ridges on both sides were divided and the cleft closed, the soft by horsehair sutures, the hard by two wires and plates. The pre-maxillary bone was then moved back and sutured in position. November 7, the wires were removed, and on November 11 two points of suture inserted in the soft structures where they were inclined to separate. December 19th, the harelip was operated on. In the second case the whole of the surfaces united thoroughly, except the uvula. In the third case the cleft in the palate could not be completely closed, and no attempt was made to deal with the soft palate. Eleven weeks after the operation the cleft in the hard palate had steadily become narrower, being quite closed in front. The harelip was operated on about three months after the first operation.

Sir Thornley advises that the paring of the edge of the palate should be deferred until the sutures have been inserted and the bones moved towards the middle line, the period for hæmorrhage being thus lessened. Further, if it be found that the bones cannot with reasonable effort be brought together, it is better not to pare the soft parts at this time. He made use of Rose's position, and, unless the jaws were sufficiently developed, employed no gag. The tongue is best kept out of the way by a curved depressor, which is not bulky and can be used as a tractor. A couple of Liston's nævus-needles of different curves sufficed to pass the sutures.

On the other hand Mr. James Berry (*loc. supra cit.*) condemned the operation of forcibly fracturing in the strongest terms. Of the 11 cases of which he had heard in this country it had led to death in 5.

In another case necrosis of the bones occurred, but the child recovered.

After-treatment.—When the child is put back to bed, warmth should be applied by hot bottles. The side position is best at first, that blood may trickle out of the mouth. When the risk of vomiting has passed, a little ice may be given. The hands should be secured for the first few days. For the first forty-eight hours milk with ice or barley-water only should be allowed, with a little port wine and water, nutrient enemata being given if needful. After this, yolks of eggs, arrowroot, broths, soups, and (in about ten days) light puddings, jellies, may be allowed. If the patient's temper and intelligence allow of it, the mouth may be regularly syringed or washed with Condyl's fluid or boracic-acid lotion. In other cases it is best to leave the wound quite alone. The nurse should devote herself to preventing the child from crying, and to keeping the patient amused. Whenever it is possible the child should be taken into the fresh air after the first two or three days (Owen). There should be no hurry to remove the sutures, which, if not of silk (p. 553), may remain for seven or ten days in the soft, and an almost indefinite time in the hard, palate. No one should be allowed to look at them either early or often. It is well for the operator to keep out of the child's notice for the first few days. To prevent the child getting the fingers into the mouth it is well to mould felt splints in front of the elbow-joints. These will allow of movements of the hands and use of toys. Dr. Peck (*loc. supra cit.*) considers that a dental plate, fitted beforehand, is of great value in protecting the line of suture from the tongue. It can only be employed in patients of sufficient age and intelligence.

To make this subject of after-treatment at all complete a few words must be said about the improvement of speech after the cleft has been surgically cured, and the occasional need of an obturator. Even after a complete closure of the cleft much awkwardness of speech is liable to remain, this being, of course, the more marked the older the patient is. Parents are often greatly to blame for the little trouble they will take to further the success of the surgeon's efforts, and this refers in many cases to those who have not the excuse of the ignorance and toilsome life of the poorer classes. They too often act as if, because the cleft is closed, no further responsibility rests with them. Again, the patients being usually children, without thought as to the future, and satisfied with the improvement in their deglutition, present many difficulties. Not only has the child to be taught the right way of using its organs of speech, but wrong habits, especially nasal and guttural tones, have to be unlearned. This is only to be brought about by means of systematic lessons and practice gone through regularly day by day for months and even years. No plan will be found better than that recommended by Mr. W. Haward, Clin. Lect. "On Some Forms of Defective Speech" (*Lancet*, 1883, vol. i. p. 111): "The instructor should sit directly facing the pupil; the pupil is made to fix his attention thoroughly upon the face of the teacher, and to copy slowly his method of articulation. This should be displayed by the teacher in an exaggerated degree, every movement of the lips and tongue being made as obvious as possible to the pupil, and the more difficult sounds or movements prolonged for the purpose. Thus, for instance, suppose the word 'sister' were to be

practised, the teacher, having filled his chest with a long inspiration, would open his lips and draw back the angles of the mouth, so that the pupil could see well the position of the tongue against the teeth; he could then prolong the hissing sound of the 's,' and, finally separating the teeth as the sound of the 't' in the second syllable issues, allow the pupil again to see the position of the tongue as the word is ended. Or, for another example, take the word 'lily.' Here the teacher would separate the lips and teeth, so that the tongue would be seen curved upwards, with the tip touching the hard palate; the word would then be pronounced with a prolongation of each syllable, the teeth and lips being kept open, so that the uncurling of the tongue and its downward movement are clearly seen. So, again, in teaching the proper method of sounding such words as 'wing' or 'youth, much aid is given by keeping the lips somewhat separated, so that the relation of the tongue and palate can be made manifest. The pupil must be made to fill his chest,* and then to imitate as closely as possible every movement and sound of the teacher; and this may sometimes be assisted by making the pupil feel with the finger as well as observe with the eye the relative movement and position of the teacher's tongue and palate. There should be no other person in the room to distract the pupil's attention. It is best to continue the exercise for a short time only, and to repeat it frequently, rather than fatigue the child by a long lesson; and it is a good plan to take an ordinary elementary spelling-book and to mark the words which the pupil finds most difficult to pronounce,† so that these may be especially practised."

With regard to the question of obturators and vela, in cases where it has been found impossible to close a very wide cleft, or where it is evident that even after a successful operation the palate will be so tense and short as to be quite unable to touch the pharynx, and so shut off the nose from the mouth, an obturator may be required. A very useful form, that of Dr. Suersen, of Berlin (*Brit. Med. Journ.*, 1882, vol. ii. p. 875), and several others, are described by Mr. Newland Pedley (*Guy's Hosp. Rep.*, 1894). The whole question is very fairly dealt with, and many useful hints are here given as to the improvement of speech in these cases. The chief disadvantages of instrumental aids are that if fitted early they will require frequent alteration; on the other hand, unless worn early they will be of little service. Moreover, the expenses of the necessary repairs and renewals can rarely be met by hospital patients. Just the same care in overcoming faulty habits of speaking and in teaching correct ones is required now as after a successful operation.

Causes of Failure.—1. Vomiting.† 2. Premature cutting of sutures from tension. 3. Hæmorrhage. Serious hæmorrhage in children, either at the time or later, is very rarely met with. In case of severe hæmorrhage during the operation Mr. Berry's advice is worth remembering. "If a smart hæmorrhage occurs, the knife should not be at once

* Opening the mouth widely and learning to keep the tongue down on the floor of the mouth are two points to be early and strenuously insisted upon. The patient should practise them before a looking-glass.

† Especially those containing the letters t, b, d, k, g, s, z, and l. (Rose.)

† Mr. Mason (*Brit. Med. Journ.*, 1872, vol. i. p. 14) gives the case of a child, aged 9, where the vomiting of two lumbrici led to failure.

withdrawn, but made to cut a little further, so as to ensure that the vessel, whether artery or vein, is completely divided."

Mr. H. Marsh (*Clin. Soc. Trans.*, vol. xi. p. 71), in the case of a patient aged 21, was compelled to plug the posterior palatine canal owing to severe hæmorrhage on the sixth day.

The hæmorrhage recurred twice, the last time being as late as the fourteenth day, and was arrested on each occasion by the following means: "Searching with a sharp-pointed probe, passed through the lateral cut, about $\frac{1}{4}$ inch in front of the hamular process, which can be easily felt through the soft palate, and about the same distance directly inwards from the wisdom tooth, I felt, after two or three attempts, that I had fixed the probe in the orifice of the canal, and at the same time the patient screamed with pain when the large posterior palatine nerve was touched. A wooden plug, made by sharpening a piece of firewood, was then pressed firmly into the canal, by holding it in a pair of strong forceps with its point looking upwards, and a little backwards in relation to the roof of the mouth. Directly the plug was introduced the bleeding ceased." The recurrence was due to the plug slipping out.

4. Whooping cough. 5. Exanthemata. 6. The child putting a finger into the wound. 7. Swallowing of solid food. 8. Feeble condition of the child, with congenital syphilis, &c. Children of defective mind always cause additional anxiety in the after-treatment. 9. Acute infantile diarrhœa. Though I have placed this last, this baffling pest of surgery is too well known to those who have to operate, in the summer, on little children in hospitals. For the best account of treatment I would refer my readers to an article by Dr. G. E. Halstead (*Guy's Hosp. Rep.*, 1898). I here append a summary of his terse and most practical article:—"Diarrhœa is due to something in the diet. Empty the bowels and keep them cleansed, preferably by castor oil. Energetically treat the collapse, and don't trouble about the number of motions. Don't stop up the bowels by astringents and opium. Give hardly any food for a few days. Begin with white of egg solution in teaspoonful doses every half-hour. If the baby is too hot, cool it; if it is too cold, warm it; if it is thirsty and not sick, give it water; and keep it in the fresh air all day long."

With reference to the above causes of failure, while, very occasionally, hæmorrhage at the time of the operation in a weakly child, prolonged vomiting, or want of supervision after the operation, may be the cause, in the very great majority of cases the failure is due to some neglect of the precautions which are recognised as essential. They are (a) insufficient relief of tension on the sutures by inadequate use of the raspatories in freeing the muco-periosteal flaps when the lateral incisions are made, or in separating the soft parts at the junction of the hard and soft palates. (b) Unskilful paring of the edges, by which either not enough is done, the cleft not being completely pared, or too much is removed and the tension thereby increased. (c) Bruising of the edges from unskilful manipulation with instruments or sponges, difficulty in passing the sutures, &c. In some cases where, in spite of free separation of the parts, the operation occasionally fails, perhaps from the presence of much scar tissue, union may still be secured, much as in the case of a harelip (p. 528), if about the tenth day the edges are carefully pared, and drawn together with sutures of salmon gut or silver wire, sufficiently stout not to cut through readily, and not drawn too tight. The sutures of relaxation of which I have spoken (p. 558),

- should be used here. The explanation of this happy result, which I have experienced in two cases, is probably found in the abundance of vascular loops now present on either side of the cleft. In the case of a partial union, where one or more holes persist, there should be no hurry to interfere, and the child should be got into the best possible condition beforehand, by a stay at the seaside, if possible. Where a gap remains in the soft palate, the course to be taken will be, according to its width, either a fresh operation on the former lines, or one in which a flap is employed by Mr. Lane's method (Figs. 238, 239).

REMOVAL OF GROWTHS OF THE PALATE.

Growths here, though rare, have a special interest, from their position, and may thus be briefly noticed. For a good account of them I would refer my readers to a paper by Mr. Stephen Paget (*St. Barth. Hosp. Rep.*, vol. xxii.), in which the following points are brought out: (1) The chief groups are the polypoid and warty, the adenomatous, the sarcomatous, and the carcinomatous; this last including the encephaloid, which are very rare, and the epitheliomatous, commencing in irritation here as elsewhere. (2) That it is hardly possible to tell beforehand to which group the growth belongs. (3) Many of them, especially the adenomata, can be shelled out with surprising ease. (4) That the growth itself should not be cut into.

The commonest growths which the surgeon has to deal with here are sarcomata and epitheliomata. In either case, where the growth is large and vascular, I strongly urge the advisability of making use of such aids as a preliminary laryngotomy and plugging the fauces, slitting the cheek and ligaturing the external carotid on the side in which the growth extends farthest back. Tying the above vessel not only renders the operation much more bloodless, and so enables it to be more thoroughly done, but diminishes also the risk of secondary hæmorrhage, a risk that in a part like this, which cannot be kept aseptic, is always present. I have followed the above course in two cases, in each of which the disease implicated the pterygoid region on one side. One was an epithelioma of the hard and soft palate involving the alveolar process and the pterygoid region on the left side. This patient was alive and well, four and a half years after the operation. In the other case, one of sarcoma of the right pterygoid region and the soft palate, an operation had already been attempted by a surgeon at Johannesburg. Ligature of the right external carotid allowed of the removal of some enlarged glands at the angle of the jaw, and prevented any severe hæmorrhage when the growth was shelled out of the palate and right pterygoid region. I heard of this patient in 1905, five years after the operation; he was married and fruit-farming in California. The parts were perfectly sound.

In the case of a growth of the hard palate, peeling it off with a blunt dissector and scraping the bone will be quite insufficient. The bone around should be freely removed with a chisel or gouge and mallet, or a partial removal of the upper jaw (*e.g.*, its palate and one alveolar process) performed, if needful.

CHAPTER X.

REMOVAL OF THE TONGUE (Figs. 242 to 246).

THE day when the belief is accepted, and acted upon, that cancer of the tongue, like many other epitheliomata,* has a pre-cancerous stage, and that this is the stage in which we ought to operate, will be a happy one for hundreds of patients and for the results of surgery. Of all the painful deaths by which men leave this world there are few more miserable and distressing than one which closes life by cancer of the mouth. And yet, though in the case of the tongue this most important stage is, from the position of the organ which it attacks, peculiarly under our eyes and lies open to our examination and detection, how frequently it is overlooked! I have elsewhere (*Guy's Hosp. Rep.*, 1889, p. 245; *Practitioner*, May, 1903†) treated in detail of this malignancy and the other practical points above given.

Before describing the different operations it will be well to say something with reference to two or three very practical points which rise up with every case of tongue cancer, a form of cancer which, it must be remembered, is very frequent, and increasing in frequency;‡ which attacks all ranks of life; which, after its early stage, is especially malignant;§ and, finally, for the relief of which an operation is as much dreaded and deferred by men as that for carcinoma mammae is by women.

A Pre-cancerous Stage.—However tongue cancer begins, it passes through the above stage, *i.e.*, a stage (the duration of which is unknown, and varies extremely) in which inflammatory changes only are present, *viz.*, ulceration and other changes in the epithelium, not amounting, as yet, to epithelioma, but on which epithelioma inevitably supervenes. The boundary line between this pre-cancerous stage and cancer is extremely narrow; the duration of this stage may be, and often is, extremely brief.

* The rare sarcoma of the tongue is alluded to at p. 606.

† The remarks on diagnosis of the pre-cancerous conditions in this article (p. 614) may be found useful. In the same journal (p. 595) Mr. Butlin relates cases illustrating the occasional difficulty experienced in the diagnosis of epithelioma here.

‡ Amongst common cancers—*e.g.*, of breast, rectum, uterus, &c.—cancer of the tongue stands about third, although so rare in women. Mr. Barker, in his carefully worked-out article on "Diseases of the Tongue" (*Syst. of Surg.*, vol. ii. p. 578), gives a series of tables showing that in the previous thirty years there had been a steady increase from 2.6 to 11.5 per cent.

§ This is shown in the following facts: (a) The rapidity here is quite different from that in other epitheliomata. Epithelioma, usually thought a slow cancer, here, in a moist, warm cavity, much irritated, and never dry and warty, is terribly rapid. (b) Gland invasion is here not only certain, but inevitably early as well.

Aids in recognising this stage : (1) The duration of the ulcer. (2) Its obstinacy to treatment. (3) The age of the patient. (4) Absence of any induration or fixity.

Questions arising before Operation.

The operating surgeon will often be called upon to give an answer to the two following questions: Will the disease be permanently cured? If a permanent cure is impossible, will life be bettered and prolonged?

A. *Will the disease be permanently cured?*

Really permanent cures, *i.e.*, cases in which no reappearance of the disease has shown itself five years after the operation on the tongue are, as a matter of common knowledge, still very rare. From my own experience—and it has been a large one, chiefly of advanced cases—the proportion of permanent recoveries carefully watched would not be above 12 per cent. Reappearance *in the tongue* after a well-performed operation is rare, but as the glands are invaded in the great majority of patients by the time they come to us, a permanent recovery is in these cases exceptional, however thoroughly repeated operations are performed.*

Mr. Hutchinson (*Brit. Med. Journ.*, vol. ii. 1891, p. 1190) drew attention to the following facts, which cannot be emphasised too strongly. Gland infection here begins almost from the very day that the sore assumes suspicious features.* Again, lymphatic glands may become involved through ulcers of the most insignificant size and of the briefest duration. Lastly, the same authority points out that cancer germs may remain latent in the lymphatic glands for several years and then evolve disease. Before leaving this subject I would earnestly impress upon my younger readers that invasion of the glands is here not only certain, usually early, but also now peculiarly baneful, owing to (1) the way in which epithelioma infects the glands—*inflammatory cells, as well as those of cancer, passing from the primary growth, if ulcerated, as it usually is, into the glands*; and (2) *the great importance of the structures amongst which the cervical lymphatic glands lie*. When epitheliomatous glands are operated on, the following conditions interfere with a thorough extirpation of the disease: (a) The number of the glands and the abundant communication between the different groups, the importance of the structures closely adjacent to the deeper ones, and the fact that the glands may be affected and yet so minute as to escape the most careful operator. (β) The presence only too often of septic cells (the original trouble being, usually, an ulcer) as well as of malignant deposit in the glands so mats them to adjacent parts as to make it quite impossible to really extirpate the glands. Inflammatory softening having set in leads to their breaking down during attempts at their removal, with the result that shells, still the seat of cancerous foci, are left behind. These relics, owing to the vascularity of the surrounding parts, do not die, but preserve sufficient vitality to act, a little later, as centres of recurrent disease.

* If a sore has been persistent for longer than three months, permanent recovery is very doubtful. If it has persisted for over six months, if more than one-third of the tongue is invaded, if the floor of the mouth is involved, permanent recovery is well-nigh certainly hopeless.

The explanation of the small number of permanent recoveries after removal of cancer of the tongue* is not altogether to the credit of our profession. Patients and we, alike, are too often both to blame. The gravity of the disease is overlooked, the time of the "pre-cancerous stage" is lost. Because cancer of the tongue is so often preceded by syphilis, or local irritation, the practitioner diagnoses the above, and suggests them as the essential part of the mischief: "give drugs another chance"—*e.g.*, potassium iodide, mercury, caustics.† To these there are, in nearly every case, the strongest objections in the pre-cancerous stage. Time is lost, strength is lost, and the patient is lulled and befooled, while all the time the vascularity and irritation around the ulcer are increased. Furthermore, the patient is in part responsible for the delay, as he very naturally dreads the operation, exaggerating its danger, painfulness, and the supposed inevitable loss of speech. We shall never be able to successfully combat the above till (1) the importance and value of the pre-cancerous stage are recognised and thus limited operations are justified; (2) when medical men will assure their patients that even after more extensive operations, sufficient power of speech will remain. In the tongue and in the lip, especially, it is time that patients knew that the cure of cancer which they are always expecting others to find and the responsibility for letting it go by rests with them.

B. *If a permanent cure is impossible, will life be bettered and prolonged?*

Cases which are not operated on die within eighteen months, many in twelve months. An operation wisely planned and well carried out often gives a gain of six or eight months. This is a gain not only of time, but also of comfort. Death by glandular recurrence in the neck is less painful and noisome than death by mouth cancer. No one who has seen much of tongue cancer will have any difficulty in answering the question which of the two is the more painful to the patient and distressing to those around him—tongue cancer with its horrible fœtor, profuse and foul salivation, its pitiless, incessant, weary, racking aching of tongue, ear, face, and teeth; or recurrence in the cervical

* Anyone doubting the truth of this statement should refer to a very practical instructive article by Mr. Stanley Boyd and Mr. Unwin (*Practitioner*, May, 1903). The following is the summary of the results in 33 cases: One case remained free from cancer after 11 years. One remained free from a cancer of the right side of the tongue for 8½ years, and 2½ years from a second operation for a cancer on the left side of the mouth. Two died free from cancer after 6 and 4½ years. One (frenal) was free after 2½ years. One was free after 11 months. Eight died soon after the operation. In 16 others the disease recurred within a year. In one, the disease recurred in a gland low down in the neck after 4½ years. One recurred *in loco* (frenal) after 3½ years. One recurred twice in the glands during the first two years, there being no further recurrence locally or in the cervical glands until the patient's death from intra-thoracic deposits 4½ years after the first operation.

† "While a careful thorough application of nitric acid or acid mercury nitrate is perfectly justifiable in certain cases, and may be highly beneficial, the use of caustics frequently repeated at short intervals is here futile and perilous. For medical men to waste time with this treatment should at the present day be almost criminal, for such dallying with drugs and local applications can only lead to cultivation of cancer, and most miserable and often untimely deaths" (article, *loc. supra cit.*, *Guy's Hosp. Rep.*, 1889).

glands, an alternative in which the patient is often able to work up till near the last, and, till towards the close, is free from the agonising tenderness, the stinking fœtor, the dribbling of foul saliva (not only half-poisoning the patient, but rendering him noisome to others*), and the slow starvation day by day of tongue cancer. Where an operation is certainly attended with risk, the patient in facing it may be relieved by the assurance that a life prolonged in hideous misery and constant agony is worse than death following close on an operation. "When a man has only, suppose, two or three years to live, it is no small advantage if at least half the time can be spent in comfort rather than in misery, and in profitable work rather than in painful idleness" (Paget).

If a patient cannot make up his mind to an operation and is losing precious time, he should be warned, without being unduly frightened, of the state of things, alluded to a few lines above, which will inevitably follow. Usually, as soon as this sets in—*i.e.*, when the condition of the tongue renders him a nuisance to himself and others with the disgusting fœtor, the constant dribbling of foul saliva which cannot be swallowed, the weary aching day and night, lit up into agonising flashes when the parts are touched or moved—the patient becomes willing to run any risk. But, too often, by this time, the glands have for some time been enlarged, and the mischief has reached the floor of the mouth or the alveolar mucous membrane by extension, though not yet perhaps with ulceration.

Operations.—The following five will be carefully described, viz.:

- (i.) Whitehead's.
- (ii.) Syme's, on which Kocher's present operation is based (Fig. 244).
- (iii.) Kocher's former operation (Fig. 245).
- (iv.) Trans-Hyoid Pharyngotomy.
- (v.) The *Écraseur*.

With these, certain aids—*e.g.*, slitting the cheek, preliminary laryngotomy, and ligature of the linguals—will also be considered.

While the above operations—and I allude especially to the first two—give a choice which will enable the surgeon to meet any case of tongue cancer, whichever is chosen must be completely carried out: "niggling" operations lead inevitably to return and accelerated growth in the tongue itself.

Preliminary Treatment.—Whichever method is chosen the following details are to be attended to carefully. For as many days as possible before the operation every pains should be taken to get the mouth clean. All loose teeth or stumps, and all tartar should be removed; and a strong formalin solution or pure carbolic acid applied to the epitheliomatous ulcer, several times. Mr. Stanley Boyd (*loc. supra cit.*) thinks that recurrence may be occasionally due to direct inoculation of raw surfaces by the growth as it is dragged past them, and proposes in future to apply the cautery to the growth before beginning the operation. The patient should brush his teeth two or three times in the day, and make himself handy in washing out his

* "Recalling the 'male gratus amicis' of Deo, the close of whose life brings, week after week, rest, and has not longed exceedingly for a while of tongue cancer, and for earlier operations in

feeder and tube. Much too often these most important steps are left till after the operation, and to a nurse. If practised beforehand they occupy the patient's thoughts, and after the operation they are not a new thing to him; and no one, however much in earnest, can carry it out as well and as painlessly as the patient himself. As to the mouth-wash used, I am of opinion that it is not so much any particular kind that is of value, but the way in which it is used; and, from its unirritating nature, I usually tell the patients to use Condyl's fluid. Solutions of chinolol or carbolic acid are excellent. Before the operation the surgeon should take note of the teeth, as to their cleanness, and whether sufficient molars are present to take the leverage of the ordinary gag. If this is not the case, he should be provided with Dr. Hewitt's wheel-gag (p. 587). He should also be quite clear in his mind as to the extent of the growth. The transverse incision behind the growth should always lie a full inch posterior to the cancer. Only in some cases involving the posterior third is this occasionally impracticable. Even in doubtful cases it will be wiser to make a rule to adopt the above margin. Every surgical registrar of experience is familiar with one or two cases where he has been asked to clear up the nature of an ulcer of the tongue in which different opinions have been expressed as to its malignancy. In such cases he may have to cut section after section before he finds the part which is actually epithelioma. If this be so in section-cutting, it is clear that, if the portion actually epitheliomatous lie at the back of the sore, the surgeon who cuts within three-quarters or half an inch of the sore may be removing too little. If he leaves any examination to be made at the time of the operation, his finger may not only become infected, if he be dealing with an ulcer, as is usually the case, but he will very likely start bleeding, which is needless, and may be embarrassing, if the anæsthetic at that moment be causing difficulties.

(i.) **Whitehead's.***—The *advantages* of this are very great. They are: (a) The transverse section of the body of the tongue can be placed, deliberately, well behind the growth. However far behind the growth the loop of the *écraseur* is placed before the operation, and however securely it seems to be retained *in situ* by large curved needles, as the loop is tightened up, owing to the enormous strain which is gradually applied, the needles and the loop are forced forwards nearer and nearer to the growth. Now the whole neighbourhood of this is ready to become the seat of malignancy. All around the growth the epithelial columns are ready to dip down into the vascular connective tissue beneath, on which, in health, they never encroach. Again, the parts around are loaded with inflammatory cells, soft and vascular. If, as is very likely, owing to the tremendous tension to which it is submitted, especially when the parts are very soft, the loop comes crushing into this neighbourhood and makes the section here, the indipping processes which extend for some distance around the actual epithelioma may, owing to the vascularity and inflammation consequent on the operation, break out into speedy reappearance. Again, the insertion of the needles which are intended to keep the loop well behind the growth is not always

* Mr. Whitehead's latest account of this operation will be found in the *Practitioner*, May, 1903, p. 595.

an easy matter, especially if the growth is far back, and if the front teeth are well developed whilst the molars and pre-molars are too deficient to allow of wide opening of the mouth with a gag. (b) The resulting wound is very clean, there being very little laceration and no charring. The slight decomposition which would take place from an extensive operation, even with scissors, is readily checked by the use of the lotions mentioned above. The advantage of this in saving a patient, whose vitality is already often lowered, from the depressing effects of being liable for days to breathe and swallow with a foetid sore in his mouth, in securing rapid granulation and healing, and thus enabling the patient to be early propped up, and soon to leave his bed, must be obvious to every surgeon who knows how great is the risk of fatal broncho-pneumonia in these cases. For the same reason secondary hæmorrhage, where ordinary care is taken, is unknown. (c) The instruments required are extremely simple and few, as will be seen from the account of the operation.* The chief *disadvantage* of Whitehead's method is that it does not permit of the surgeon cutting deeply in cases where the growth has extended along the muscles towards the hyoid bone. To such cases it is unsuited, and Syme's method is always to be preferred.

The Operation.

It is most essential that the anæsthetic should be in the hands of a man who can be thoroughly trusted. It is often taken badly in these cases, with much dyspnœa and restlessness at first; and, during the operation, owing to the open mouth admitting much air, and the fear of interfering with the operator, the patients often "come to" prematurely. The only thing is to get them well under at first; later on it will be well not to keep them too much under the influence of the anæsthetic, in order that, the sensibility of the larynx not being lost, the blood may not enter the air-passages. The administrator must watch the tint of the lips, the veins in the cheeks, and know when a little blood is only safely, though noisily, bubbling at the back of the fauces, and when it is getting into the trachea. If he keep note of the tint of the parts mentioned above, he need not render himself and the operator anxious by repeated, more or less furtive, examinations of the radial pulse. As long as these parts are sufficiently red or pink all is well; they quickly show a tendency to lividity on the one hand, and pallor on the other. I consider the administrator of anæsthetics in these cases to be nearly as important as the operator. Two reliable assistants are needed who understand the steps of the operation, one to take the gag in charge, and to sponge when needed, and the other to hook back the corner of the mouth with two fingers while he is ready to sponge, and thus, with the position of the head over to this side, enable the blood to escape freely from the wound into the cheek and out of the mouth, with the aid of deft sponging. Two nurses should be ready to supply sterile sponges or gauze pads firmly secured on holders. The following instruments should be close to the operator's right hand—viz., scissors,†

* On the value of Mr. Whitehead's method Mr. Butlin writes (*Oper. Surg. of Malignant Dis.*, p. 154): "Whitehead's operation for removal of one part or the whole of the tongue has been my stock operation for the past ten or more years."

† Mr. Whitehead hearing, in 1881, that I had twice operated by his method—I that they were the earliest of the kind performed in London—kindly sent me a pa

several pairs of Spencer Wells's forceps, curved on the flat, a needle in a handle, threaded with stout silk, some medium-sized ligatures of sterilised silk and fine needles threaded with sterilised catgut.

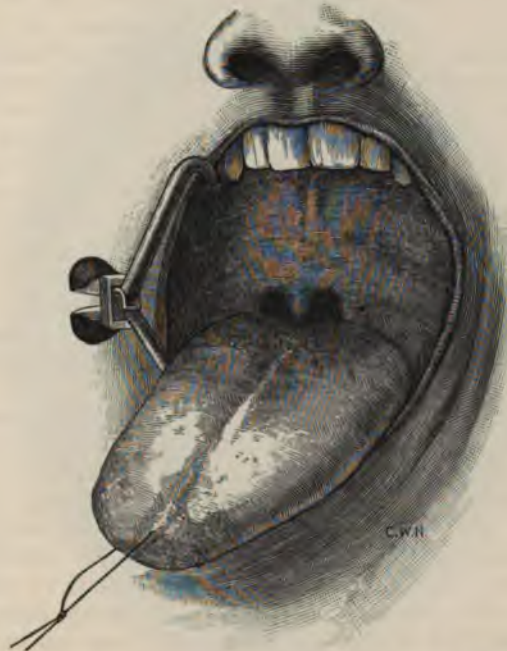
A good light is absolutely essential. Daylight close to a window is far the best. If it is needful to operate when the above cannot be obtained, as in a succession of foggy November afternoons, a good head-lamp will be useful. But no tongue should, if it can be avoided, be removed on a foggy day, not so much on account of the light, but because of subsequent respiratory trouble. In making arrangements for a good light, the surgeon will remember that, while the removal itself takes but a short time, getting the patient under the anæsthetic, and keeping him under its influence, often render the operation much prolonged. It may not be superfluous to add here that this is an operation which calls for coolness and decision on the part of the operator, and for promptness with their help on the part of all those who assist. The surgeon must be cool and deliberate at three periods especially, (1) In taking up all bleeding points which are not checked by pressure and by pulling on the tongue; there must be no hurried and often futile snapping at such hæmorrhage; (2) In making the transverse incision, the operator's mind must be absolutely decided where he is going to cut, and he must not forget the fact that it is no good cutting well *behind* the growth if the section *below* is made dangerously near it; (3) When the tongue is removed, there must be no hurry in taking the patient back to bed before all bleeding is thoroughly arrested. As long as any blood tends to trickle out of one corner of the mouth some vessel, probably one of the linguals or a dorsalis linguæ, requires tying. Yet another condition calling for patience and coolness on the part of the surgeon is where the patient, because he was not sufficiently anæsthetised at first, or from some delay in the operation, requires additional anæsthesia. No crowding on the operator, no obstruction to the light by bystanders, should be permitted for a moment.

Preliminary Laryngotomy.—The question of the advisability of this operation now arises. It forms no part of a Whitehead's operation proper. The operator who introduced the scissors-method, and whose success with it is so well known, never, I believe, uses a preliminary laryngotomy. In my first 6 cases I followed him closely. Among the later 53 I have performed laryngotomy on many occasions. With a wider experience, I am led to think very highly of this preliminary step, and of the plugging of the back of the mouth, which it renders safe, and I do so for this reason. With the fauces plugged, and the patient breathing through a laryngotomy-tube, the surgeon can neglect the hæmorrhage more, can so operate more deliberately, and thus (and this is the value of this preliminary step, in my mind) at every step of the operation can have the parts more thoroughly sponged dry, and consequently is enabled throughout to keep more surely wide of the disease. In other words, I do not dread the hæmorrhage which accompanies a

scissors. They are rather longer than usual, perfectly flat, very sharp up to the tips, which are square and blunt. While Mr. Whitehead first placed the operation by scissors on a firm basis, Mr. Fiddes, of Jamaica, one of the first surgeons to remove the tongue, used the scissors nearly fifty years ago (*Path. Soc. Trans.*, vol. xii. p. 223; *Edin. Med. Journ.*, 1859).

scissors-operation for itself, but because it is liable, in spite of careful and prompt sponging, to obscure the field, and thus lead to cutting dangerously near the growth—a danger especially likely to happen if the hæmorrhage is at all free, if the parts cut are very much softened, and if the patient is not taking the anæsthetic well. For these reasons I am inclined to recommend a preliminary laryngotomy, with plugging of the fauces, in these cases: (1) When a surgeon who values Whitehead's operation is doubtful as to his means of meeting hæmorrhage. (2) When the growth extends beyond the middle of the tongue, into the posterior third. (3) When the floor of the mouth is at all involved. In growths limited to the anterior half of the tongue, unless

FIG. 242.

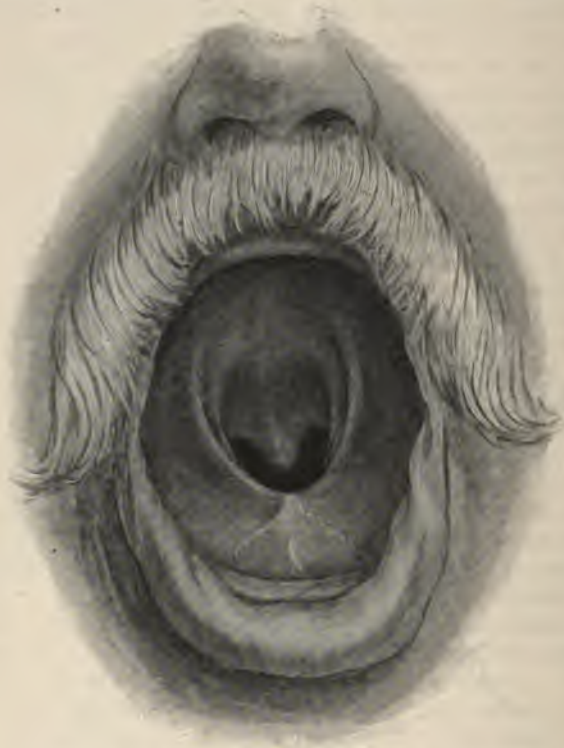


there is much fixity, laryngotomy is not needed, for, as will be seen below, sufficient of the tongue in such cases, after very little use of the scissors, comes right out of the mouth. (4) This question is also affected by the experience of the anæsthetist. In February, 1899, I removed the entire tongue, in a patient sent to me by Mr. Buxton Shillitoe, without performing laryngotomy. But I should add that I had the advantage of Dr. Hewitt's services as anæsthetist. In this patient the growth extended so far back that it would have been difficult to divide the tongue sufficiently widely behind the disease, had there been a sponge in the fauces. This patient's mouth is shown in Fig. 243. Lastly a laryngotomy, especially if the tube be removed at the close of the operation (*vide infra*) is not attended by the same risks as a tracheotomy. With this operation it is well founded.

If it be decided to perform laryngotomy, it is done as at

p. 625, and a soft sterile sponge is tied with silk into appropriate size and fixed at the back of the fauces, the silk being brought out of the mouth and held by a finger of the left hand of the assistant who has charge of the gag. This sponge must be pressed well back, and care taken that it does not draw back and down the base of the tongue, or it may cause some difficulty in securing the linguals when the transverse section of the tongue is made far back. In a prolonged operation, where the sponge becomes soaked with blood, it must be

FIG. 243.



Condition of mouth a year after complete removal of the tongue in a patient of mine, aged 67. The absolutely edentulous jaws (footnote, p. 587) are to be noted. The case is further alluded to at pp. 589 and 591.

renewed. The anæsthetic is now continued through the tube, an additional advantage brought about by the laryngotomy, as the administration of the anæsthetic does not interfere with the field of operation. So very little sloughing and swelling follows on Mr. Whitehead's operation, that I have usually removed the laryngotomy-tube before the patient has left the operating table or as soon as he is back, in bed.

Whether laryngotomy is performed or not, the patient, having been propped up, is brought quite to that side of the table on which the

surgeon stands. A gag* is placed on the side of the mouth opposite to the growth, and the mouth widely opened. The tongue is then trans-fixed on the diseased side, well back in its anterior third, with a needle in a handle, loaded with stout silk; this is looped and knotted, and the tongue thus well drawn out of the mouth. The surgeon then, where one half can be spared, with a sharp-pointed bistoury splits the tongue longitudinally along the raphé, to a point thoroughly well behind the growth. It has been said that leaving half the tongue is useless, the part left being but little under the patient's control. I am of an entirely different opinion, for reasons given below.

The diseased half or the whole tongue being drawn well out of the mouth by means of a stout silk loop or reliable tongue-forceps, the surgeon next divides with scissors the mucous membrane between the tongue and the alveolar process, keeping close to the bone so as to be wide of the disease. The anterior pillar of the fauces is next divided. While the above steps are taken, an assistant sedulously sponges away any hæmorrhage into the hollow of the cheek and out of the mouth, the cheek being retracted as above directed. Careful sponging, and sponge-pressure on bleeding points, are most essential if the surgeon is to see his way and cut wide of the disease.

If the disease has implicated the frenum and its vicinity, two or three of the lower incisors should be drawn, so that the scissors may be introduced on a level with the disease. If this be not done, the scissors have to be dipped in over the teeth in an awkward way, and one which, as soon as bleeding occurs, makes it impossible to be certain of getting below the disease. The scissors can be introduced with much greater facility, and used to much better purpose, if a gap be made in the teeth. These, if sound, can be kept, and, later on, fitted to a plate by a dentist.

When half of the tongue has been freed all round, the muscles between it and the floor of the mouth are cut through with a series of short snips until the diseased half is separated on the level of the lower part of the jaw, and well beneath the growth, as far back as is needful. Where the surgeon feels that he is cutting dangerously near the base of the growth, the tongue should be raised by a vulsellum-forceps grasping it laterally. During this stage oozing will take place, and one or two small arteries jet with varying freedom in different cases, but these will yield to pulling steadily on the tongue, and to firmly applied sponge-pressure.

The tongue having been freed horizontally up to a point well behind the disease, the transverse section is now made, and here arises the

* Of these I prefer Dr. F. W. Hewitt's modification of Mason's gag as the readiest and most efficient in cases where sufficient teeth are present. The patient should be got thoroughly well under the anæsthetic (the degree of anæsthesia being just short of abolition of the laryngeal reflex). I prefer ether first, when the state of the lungs and vessels admits of it, or A. C. E.; chloroform may be given afterwards with a Junker's apparatus, and a tube through either the laryngotomy wound or the nose. I believe this drug to be quite safe at this stage, and it diminishes the congestion due to the ether. The same well-known and ingenious anæsthetist has lately supplied a want long felt by operating surgeons—viz., a gag that will widely separate the edentulous jaws so often met with in patients the subjects of tongue cancer (Fig. 243). I refer to Dr. Hewitt's wheel-handled gag, made by Weiss.

question as to the best way of securing the lingual artery. By far the most accurate is that of Mr. Cathcart, surgeon to the Edinburgh Royal Infirmary. Many of us have been in the habit of finding the lingual artery by cutting down on it gradually as the deeper parts of the tongue are divided: Mr. Cathcart has put this most important step on a definite anatomical basis (*Ann. Surg.*, July, 1902, p. 15). His method is founded on the fact that the hyoglossus under which the lingual artery runs, though attached to the posterior third of the tongue, can be reached from the mouth when the tongue is drawn far out, and the mucous membrane has been divided between it and the jaw. The jaws being opened widely, and the tongue drawn forwards with a stout silk ligature in each half, the mucous membrane is divided along the middle line of the dorsum, behind the growth and between the tongue and the jaw; the tongue is split and the fibres of the genio-hyoglossus divided close to the symphysis with scissors. The diseased half of the tongue can now be drawn well out of the mouth, especially if the anterior pillars of the fauces have been snipped through as well. With a few vertical strokes of a director the anterior edge of the hyoglossus is next defined. The director is then insinuated beneath the muscle, the tissues being separated with the point before the instrument is pushed on. The muscle is next carefully cut through on the director for about two-thirds of its extent, and the fibres retracting leave the artery at the bottom of the wound covered only by a little connective tissue. With the point of a director the vessel can then be easily defined as a bluish cord, and traced downwards and backwards. An aneurysm-needle should then be passed under it, and the vessel tied before it is cut. Some may prefer to seize it with forceps and cut before tying it, but the previous ligature is easier. After the artery has been ligatured and divided, a few snips should be made with the scissors radiating out from the ligatured artery into the substance of the tongue; this lessens the chance of cutting the artery again in the later stages of the operation. All that now remains to be done is to complete the operation, cutting wide of the disease. The advantages claimed by Mr. Cathcart for his method—and anyone making use of it will confirm every word that he says—are ease and certainty in securing the lingual; diminished bleeding from small vessels; greater certainty in cutting wide of the disease. Mr. Cathcart finds that, by his method, the same part of the artery is reached as is tied in the usual operation for a preliminary ligature in the sub-maxillary triangle.

Mr. Whitehead (*loc. supra cit.*) thus describes the securing of the lingual arteries. After the division of the frenum, anterior pillar of the fauces, and mucous membrane on either side of the tongue as far back as the anterior pillar, almost the entire tongue can be pulled out of the mouth. "Now the more critical part of the operation commences—the one most dreaded by the inexperienced. Having proceeded so far in separating the tongue with scissors, the timid surgeon need make no further use of a cutting instrument. The tissues can be ruthlessly broken down and torn asunder. With a dry dissector he can break down the remainder of the friable tongue, and expose the arteries and nerves as cleanly as if he was making a dissection. Nothing is then easier than seizing each artery separately by forceps, snipping the

distal end, and gently twisting the stump of the vessel. The greatest confidence may be established by the almost universal certainty that if, after the forceps are removed, no immediate bleeding of that artery takes place, no subsequent hæmorrhage need be feared."

Another method which will occasionally be found most serviceable is that of the late Mr. Heath. If any difficulty occur in dealing with a divided lingual (Mr. Cathcart's methodical plan should prevent this), especially when the tongue has been severed far back, Mr. Heath advised that one or two fingers should be slipped into the pharynx over the stump of the tongue, so as to draw this forwards. This step at once arrests the hæmorrhage by pressure, and usually brings into view the bleeding point, which is at once secured. The following case illustrates the value of this method:

Five years ago I had removed the entire tongue in a patient, aged 67, a retired army surgeon. The section had been made immediately in front of the epiglottis, and the condition of the mouth, a year after the operation, is well shown in Fig. 243. The excellent power of speech preserved is mentioned at p. 591. Some difficulty had been met with in securing either the left dorsalis lingual or the left lingual artery which had been divided very far back and low down. Half an hour after the patient had been put back to bed, while I was sitting beside him, blood began to well up into the mouth on the left side, the bleeding point being out of sight. Being alone with the patient, I arrested the hæmorrhage, first, by the adoption of Mr. Heath's plan, and then succeeded in clamping the bleeding point with a curved pair of Spencer Wells's forceps. These the patient—a man of indomitable courage—allowed to be retained for eight hours. No bleeding followed their removal, and an excellent recovery ensued. The patient lived for three years, and then died of bronchitis and cardiac failure, the bronchitis being, without doubt, aggravated by the difficulty in expectoration after so complete a removal of the tongue. As I had to remove some glands a year after the first operation, it is extremely probable that a further reappearance of the disease would have manifested itself.

If it be needful, the surgeon then proceeds to deal with the other half of the tongue, a step which is much facilitated by the room given for manipulation by the removal of the first half.

In this and other operations for removal of the tongue, when sufficient absolutely healthy mucous membrane can be safely left, it may be drawn together and sutured over the cut surface with sterilised chromic catgut. This step undoubtedly saves pain and promotes rapid healing. But where healing is slow, it entails a risk of shutting in infected discharges, drainage from the mouth after Whitehead's operation being very difficult. For this reason, and because the majority of cases sent to me have been advanced ones, I have not adopted this detail.

Removal of Half the Tongue.—On this subject I may quote again from my article in the *Guy's Hospital Reports*, p. 252: "(1) The removal of half the tongue is suitable and strongly called for in certain cases. (2) That such an operation, *performed in fitting cases*, leaves the patient with an organ which is (a) safe from recurrence, (β) a most useful one in speaking, swallowing, &c. (3) That it is only by operating early in these cases, and by thus being in a position to promise the patient that the less severe operation will be sufficient, and will give him immunity from disease and leave him with a most ever attain to better success in our operation of the tongue being a mu

deferred by the patient." Two cases are then given in detail in which I had removed half the tongue. *The condition of the tongue subsequently to removal of one half longitudinally.*—The following short account of the condition presented by the male patient's tongue was written three years after the operation. He remained well nine years later.

On looking into the patient's mouth, the tongue is seen to be directed constantly over to the left side by the unbalanced fibres of the right half, the tip especially being curled round to the left side and a little backwards. The mucous membrane on the floor of the mouth on the left side is, as it always is in these cases, loose and prominent from the constant dragging on it of the remaining tongue. *Mobility.*—When the patient is asked to protrude his tongue beyond the lips, there is nothing in the mouth to prevent his tongue from doing so; the tongue is pushed out between the lips, but owing to its tendency to curl round towards the left it does not come beyond them. From the same cause Mr. C. is unable to touch the right commissure of his lips with the tip of his tongue. When asked if he can touch the hard palate with his tongue, he can do so when the teeth are half an inch apart, not when the jaws are widely separated. *Speech.*—Mr. C.'s own account is that he is always intelligible, save when "excited, as in talking politics." His voice is loud and ample. His speech is clear and intelligible, save when one or two consonants, especially two dentals, requiring rapid touching of the incisors or hard palate by the tip of the tongue, succeed each other closely, as in the word "literal." *Taste.*—This, the patient says, is absolutely unimpaired. *Mastication.*—It is here only that Mr. C. allows that any difference is to be noticed since the operation. Thus, in certain actions, *e.g.*, chewing up a bitten piece of apple, manipulating a portion of herring so as to avoid swallowing small bones—in such actions as these he states that "the left half of his mouth does not act as well as the right, the latter having a little more work to do."

But while I still feel the force of what I wrote in 1889, I have not, in late years, recommended removal of half the tongue as strongly as I used to do. Increasing experience has shown to me that the cases to which the limited operation is suited, and in which alone it can promise safety from reappearance of the disease, are extremely few. I must repeat this warning clearly and decisively, having, in the last four years, seen three cases in which local reappearance had followed on removal of half the tongue, performed by another surgeon, some months previously. The variety of the disease should here be our chief guide. When the disease is precancerous or on the border line, this operation may be justifiable. But such cases are rare. To pass from such cases to those where epithelioma is actually present, it is well known to those who have had large experience of tongue cancer, that this disease attacks the tongue in two forms—the *ulcerating*, and the more or less *warty*; the former being, unhappily, the most common. I never remove half the tongue in the *ulcerating* form, unless the ulceration is evidently superficial, or when, especially in a young subject, with perhaps a long life before him, the ulcer attacks the lateral aspect of the posterior third of the tongue, and operating on the wider lines, which I prefer, means removal of the entire tongue.

I have had one case which justifies the above teaching. It is that of a gentleman, set. 34, who had epithelioma of the left half of the tongue far back in the posterior third. The ulceration, dating back to syphilitic lesions, in a patient of very delicate tissues, was stated to be of five weeks' duration and was superficial in character. My diagnosis of epithelioma, based on the character of the induration present at one spot, and at one only, was doubted by the practitioner in charge of the case. The patient, an active officer in his yeomanry, and well known in the hunting field, shrank from the complete operation which I advised,

and was willing to take his full share of the responsibility. After removal of one half of the tongue it was quite clear to the unaided eye that at one small spot the ulceration had become epitheliomatous. The specimen was examined by an expert in London, and I believe also in Berlin. The slides shown to me were typical of epithelioma. The patient remained well, when I saw him last, four and a half years after the operation. I should like to point out that this advice to remove both halves of the tongue well behind the disease in every case where the disease, though *apparently* superficial and limited, may from the duration and other facts have extended more deeply, is not the same thing as the advice to remove the entire tongue in every case of cancer, with which it has been confused.

In the *warty* form, growing outwards, and accompanied by only superficial ulceration, if any, removal of one half of the tongue is more promising. When half the tongue is removed Mr. Jordan Lloyd advises as follows:—"The half may be doubled on itself and the tip fastened with sterilised catgut to the edge of the base as far back as possible. This doubling back materially diminishes the area of the wound, lessens the risk of hæmorrhage, shortens the healing, and leaves a more useful stump than when the ordinary course is followed."

As the dread of removal of the tongue and the grievous delay to which is due the very small percentage of permanent cures arises in great measure from the fear of loss of speech, I will take this opportunity of emphasising how largely groundless this fear is. Any surgeon with experience will, like myself, have had opportunities of pointing out this fact. I will give one instance. It is that of the patient whose mouth is figured a year after his operation in Fig. 243.

A retired army surgeon, æt. 67, he had been with Lord Clyde's force at the storming of Lakhnao in 1857. While without his artificial teeth his speech was most indistinct, with their aid he told me the following in clear and vivid terms. As the force was crossing the sandy plains between Kánpúr and Lakhnao a regiment of mutineers who were known to have murdered their officers was met and surrounded. The death sentence having been passed it was decided to shoot them instead of wasting the powder of the guns. The sandy plain, the blazing sun, the dusky Sipahis dotted in little groups of two standing back to back, the English toiling about with their rifles from group to group, the absolute calmness with which the Minié bullet was awaited, with these and many other details, my patient was able to depict the scene in perfectly intelligible words.

Slitting the Cheek.—This step is an excellent one. It may be made use of, in men especially, in cases where the disease is situated very far back, extending close to or on to the anterior pillar of the fauces, where the hæmorrhage is expected to be especially free, where the light is unavoidably very bad, or where there is unusual difficulty in getting the jaws well apart.* The cheek is slit as far back as the anterior border of the masseter, the facial artery and other small branches being secured at once. The parts require most careful adjusting afterwards, especially at the corner of the mouth, where, from the dribbling of saliva, primary and exact union is not always secured. And excellent as this step is, it must be remembered that where the patient is much run down, if primary union is not secured, the difficulties of the after-treatment and the sufferings of the patient will be much increased.

Preliminary Ligature of the Linguals.—This step was very largely

* This long-standing difficulty is now largely met by the invention by Dr. Hewitt of his wheel-handled gag (Weiss).

practised by Prof. Billroth (*Clin. Surg.*, Syd. Soc. translation by Mr. Dent, p. 113). Unfortunately he expressed no opinion as to its value, merely stating that he ligatured the artery in twenty-seven cases (apparently in all as a preliminary step), that no secondary hæmorrhage ever followed, and that the wound always healed satisfactorily.

I have never taken this precaution myself, and I do not recommend it, for the following reasons:—(1) In three cases in which I know of this precaution having been taken, the hæmorrhage was as free as in the usual operation with scissors, performed without any such preliminary.* (2) I think that an experience derived from operations in over fifty cases justifies me in saying that if the operation with scissors be performed with attention to the details given above, the hæmorrhage is not so difficult to deal with as to require this precaution.† (3) The ligature of both linguals is by no means an operation that can be always done quickly,‡ and requires a good light. It may thus take up a good deal of the time required for dealing with the disease of the tongue itself. If it be answered that diseased glands can be dealt with at the same time and by the same incisions, I must state, in no contradictory spirit, that I am of a distinctly contrary opinion. Removal of epitheliomatous glands requires of itself much time and painstaking, lying, as they do, in long chains, and in relation with most important structures. If they are to be removed with that thoroughness which alone justifies any attack on them, this should be done with the full allowance of time and the undivided attention which are given by a separate operation, either before or after that on the tongue (p. 604). Further, the incision for tying the lingual artery, if the removal of glands now is found afterwards to have been incomplete, will be a source of embarrassment at a later operation.

Sir F. Treves (*Operative Surgery*, vol. ii. p. 201) is a strong advocate of ligature of the linguals before performing Whitehead's operation, for the following reasons: (1) Without it the hæmorrhage is sufficiently copious to hamper the operator. That the hæmorrhage is free with the scissors alone, none will deny. But it may be safely met by a cool and deliberate operator if the patient is kept well propped up, with the head to one side, and the cheek on that side open and retracted. Of the imperative need of a skilled anæsthetist and assistants I have already spoken. (2) That it enables the surgeon to deal with enlarged lymphatic glands, perhaps not to be felt through the skin. I freely admit the importance of this, a matter to which I have drawn attention at p. 579, and elsewhere. But as in addition to the submaxillary group many other glands must be investigated, *e.g.*, the deep carotid, I prefer to leave this, always a prolonged operation, to another time (p. 604). (3) Sir F. Treves states that ligature of the linguals is easy, and that a period of seven minutes is a fair average of the time required to secure each vessel. My reply to this is very simple. The advice I give in this

* The operations were here performed by two of my colleagues, and there could be no doubt that the vessels were secured, probably in front of a large dorsalis lingue, subsequently divided.

† In writing this I am taking it for granted that the surgeon will be aided by helpers as apt and ready as I have been fortunate enough to find.

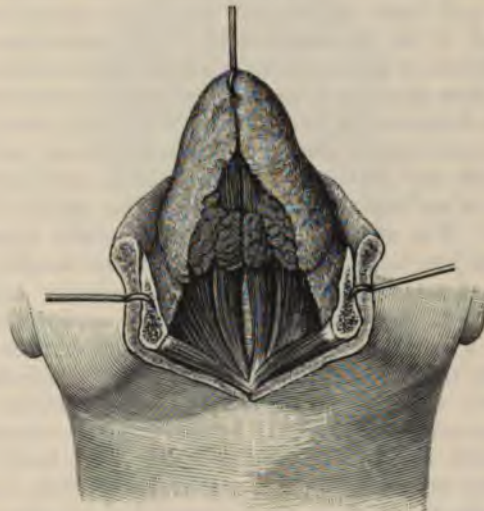
‡ The difficulties of the operation are described in the account of ligature of the artery (*q.c.*).

book is not for one moment intended to apply to surgeons of his operative experience or anything approaching to it.

(ii.) **Syme's Operation*** (Figs. 244 and 245).—This consists in dividing the symphysis menti and then removing the whole tongue and floor of the mouth with knife or scissors, or partly with one of these and partly with the *écraseur*.

It is a severer operation than the one already given, and may involve prolonged after-treatment, owing to the tardy union of the jaw. It should, in my opinion, be reserved for those cases in which the ulcer involves the floor of the mouth, or in which, in addition to an ulcer on the side, a hard mass of infiltration can be felt in the substance of the organ. Where this operation is contemplated in an aged or broken-

FIG. 244.



Removal of the tongue by division of the symphysis of the mandible. (Heath.)

down patient every attempt should be made to improve the general health previously. Prof. Kocher (*Text Book of Operative Surgery*, 4th ed. Stiles's trans., 1903) has given up the operation through the submaxillary region, and adopted what is known with us as Syme's operation. In his words (p. 109), "Our 'normal procedure' now consists in dividing the jaw in the middle line in all cases where the cancer extends as far back as the isthmus of the fauces, and where it has involved the arch of the palate." Again he writes: "It is only when there is a small new growth at the tip or the side of the tongue that we do not split the jaw." His modifications of Syme's operation are given

* *Lancet*, 1858, vol. i. p. 46, and vol. ii. p. 168. See also the account by Dr. Fiddes of his case, *Edin. Med. Journ.*, vol. iv. p. 1092. As a proof of the severity of this operation, both of Prof. Syme's first two patients died. When the symphysis must be widely removed as well the danger is much increased, chiefly owing to the impossibility of wiring the jaws here and the greater difficulty in taking food, and in expectoration.

below. The following are the advantages claimed. "It gives the best access and causes the minimum of injury. The hæmorrhage is very slight, as it is more effectively controlled; the secretions of the wound are drained away more satisfactorily, and, what is most important to our mind, by preserving the muscles of deglutition along with their nerves a better functional result is obtained than by any other method. This non-interference with deglutition is of the greatest importance in preventing secondary aspiration-pneumonia, the greatest danger which threatens the patient. It is astonishing to see how patients can swallow on the same day, the following, or at most the third day after this operation, and hence they are able to get rid of the wound secretions and prevent their getting into the larynx." With some of the above remarks I cordially agree, but against them the severity of the operation in patients usually of poor vitality must be weighed. How in the advanced cases for which I recommend this method the muscles of deglutition and their nerves can be safely spared and the result claimed attained, I fail to understand. An anæsthetic having been given and a preliminary laryngotomy performed, if needful,* the patient's head and shoulders are raised, and the surgeon divides the soft parts of the chin, as far down as the hyoid bone, if the soft parts of the floor of the mouth are much implicated: The vessels being secured, the jaw is drilled, without any previous separation of the periosteum, below the teeth a quarter of an inch on either side of the middle line, and then sawn through.† The mouth must be kept carefully sponged out, and the halves of the jaw being forcibly retracted, the tongue is well drawn out by a loop of stout silk, the mucous membrane snipped through between the tongue and the alveolar process, and the anterior pillars next divided. The genio-hyoglossi‡ and genio-hyoids are now cut through, and the tissues in the floor of the mouth separated as deeply as necessary with the scissors or blunt-pointed bistoury aided by the finger, partly by cutting and partly by tearing, any vessels that require it being tied with silk. The tongue being thus freed laterally and below as far back as is needful, the transverse section is made, one half at a time, with the precautions recommended at p. 587.

The floor is now carefully inspected, and any suspicious patches or enlarged glands most carefully removed. In raising the former, before using the scissors, a sharp hook is often very useful. If it be preferred, as where the surgeon is short-handed, though I in no way recommend it, as soon as the attachments of the tongue to the floor and sides of the mouth are sufficiently divided, the transverse section can be made with an *écraseur*, the loop of which is slipped over the tongue and kept in position by two curved needles, as at p. 599. The tongue is first slit.

* As a rule this step is not required. When the divided jaws are held well asunder, the blood flows freely out of the mouth.

† By some it is advised to saw this somewhat angularly instead of vertically, to promote interlocking and union of the fragments. As, however, necrosis may follow this as well as the other form of bone section, the longer time that it entails is scarcely worth giving.

‡ If only one half of the tongue needs removal—a rare contingency in the cases which call for this operation—the complete separation of these muscles and the consequent danger of the falling back of the tongue will alike be avoided.

The two halves of the jaw can then be wired, but to promote speedy union a cap of vulcanite or silver should, later, be fitted on to prevent displacement of the fragments. A drainage-tube should be brought through from the mouth to a point just above the hyoid bone, before the soft parts are united with sutures.

The chief modifications used by Prof. Kocher in his recent adoption of this method are as follows:—He operates with the patient in the Trendelenberg position. After section of the jaw and the preliminary division of the mucous membrane he severs the muscles, the mucous membrane far back, the soft palate and pharynx, if invaded, with the thermo-cautery. The final division of the tongue itself, after previous

FIG. 245.



The incisions on the nose are those of Ollier for the removal of naso-pharyngeal fibromata, p. 496. Below are seen three for the removal of the tongue—viz., that for slitting the cheek, and that of Syme's operation. The third is that of Kocher's first operation, the lateral infra-maxillary incision.

ligature of the vessels, is made in the same way, the use of this instrument being considered to aid in the complete removal of the disease. Xeroform is rubbed into the cut surfaces, but only in a thin layer, so as not to produce toxic symptoms if swallowed. Bismuth paste is smeared over the line of suture.

(iii.) **Kocher's Former Method by Lateral Infra-maxillary Incision** (Fig. 245).—As stated above, Prof. Kocher has now replaced this method by his modification of Syme's operation. He reserves it now for cases where there is coexisting disease of the mandible. As it is still employed by many surgeons, I have retained the account here. I will consider first the advantages claimed for the sub-maxillary route.

To take these *seriatim*:—(1) *It gives very good access.* I am of opinion that by slitting the cheek, when needful, the access given by

the intra-buccal method is quite as good. While the cheek, in spite of its usually rapid healing, should never be slit, if possible, in patients the subjects of tongue cancer and often broken down with some bronchitis and emphysema, on account of the further interference with the power of swallowing, spitting out of saliva, &c., this step must often be taken when the cancer is situated far back and the frequently edentulous jaws of these patients interfere with efficient use of the gag. But even this difficulty may be overcome by the employment of Dr. Hewitt's wheel-handled gag (Weiss), a very powerful and efficient means of opening the mouth when there are no teeth far back to support the leverage of the ordinary instruments. I will here give a hint to my younger brethren: before performing an operation for removal of the tongue always to note the condition of the molar teeth. (2) *It permits of the simultaneous removal of the glands as well as of all the tissues which intervene between them and the primary seat of the disease.* As far as the glands are concerned this is true, and at first sight it is a distinct advantage over the intra-buccal method, but I have never considered this advantage so real as to lead me to abandon Whitehead's method. When the submaxillary glands are involved by cancer, my experience teaches me that the deep carotid group are also infected, though, to the unaided eye, they may appear healthy. The complete removal of all glands that may be affected involves along and most careful dissection. I am of opinion that the close of such a severe operation as removal of the tongue is not the time for such a dissection. The majority of patients are not fit to bear further operative steps, necessarily prolonged. Few surgeons undertaking it will do justice to themselves. To mention one point only, the first part of the operation may be unexpectedly prolonged owing to difficulties with the anæsthetic. In such a case the removal of the tongue may be somewhat hurried, to save time for the operation on the glands. This certainly risks imperfect securing of vessels and subsequent hæmorrhage, and broncho-pneumonia. The anæsthetist has also to be considered. As I have stated below on the subject of removal of glands, I think the best results will usually be secured by performing this as a second operation about two weeks after the first.

As to the second claim made by Prof. Kocher, that this method removes all the tissues which intervene between the glands and the primary seat of the disease, I am unable to admit it. I cannot see how any operation, whether by the submaxillary or the intra-buccal route, can make certain of removing the lymphatic tract which runs under the jaw between the cancer and the glands. Even removing a portion of the jaw as a regular step would not make certain of this tract; and being not only uncertain but also adding enormously to the patient's discomfort immediately after the operation and for the rest of his life, this course is no more justifiable than removing part of the clavicle at the time of amputation of the breast with a view to extirpating the lymphatic tract which passes behind the vessels between the axillary lymphatics and those above the clavicle. (3) *It admits of preliminary ligature of the lingual or external carotid artery.* This claim is a just one, but any surgeon familiar with the intra-buccal method and the precautions which I have given will know that no such preliminary ligature is really needed.

This operation is a severe one; it also opens up freely the connective tissue of the neck. As already stated, it is said to have the advantages of enabling the surgeon to deal with mischief far back in the tongue and at the same time to remove enlarged submaxillary glands. The statement that the operation can be performed aseptically must be received with much caution. It is impossible to cleanse thoroughly the naso-pharynx, antrum, and other regions which lie near, and the plugging of the nostrils with aseptic wool and packing the wound with gauze, which will need changing, involve much discomfort to the patient, and are not really reliable. The mouth having been disinfected as directed at p. 581, and a preliminary laryngotomy performed, where the disease extends far back, an incision is made from just below the symphysis down to the hyoid bone, and following the digastric muscle back to the anterior edge of the sterno-mastoid, then up to near the lobule of the ear. The flap thus marked out of platysma and fasciæ is turned up, and the facial artery tied. The submaxillary region is then thoroughly cleaned out and the lingual artery secured beneath the hyoglossus. By cutting through the mylohyoid muscle and dividing the mucous membrane, the cavity of the mouth is now freely opened, and the tongue brought out through the wound and divided as far back as is needful, one half being removed after splitting the organ, or the whole tongue removed, the opposite lingual being tied if needed.

The large wound is then carefully packed with strips of sterile gauze, a drainage-tube being first inserted, and xeroform or Mr. Whitehead's varnish (p. 605) applied. The patient continues to breathe through the laryngotomy-tube until the wound and mouth are quite sweet, and thus there is less danger of infective broncho-pneumonia.

I have not myself made use of this method, for these reasons: I consider (1) that other means give as good results, and in a way more agreeable to the patient. I ought to add here that, out of fifty-three cases of Whitehead's method, I have lost six* patients from the operation. Many of these were extensive and very severe cases. Out of nine other cases in which, in addition to most of the tongue, part of the jaw was removed, I have lost four from the operation itself.

* The first of these was a Jew, prematurely aged, with epithelioma supervening on syphilis, who died, on the eighth day, of broncho-pneumonia. In the second case, that of an itinerant musician over 50, much broken down by poverty, exposure, and drink, I had removed the tongue far back for extensive epithelioma. The patient was left in bed, with orders that he should be carefully watched. For some reason these were not carried out. On my return in an hour's time I found him with his mouth full of clot, and a porringer half filled with bright blood. This was oozing from a vessel in the floor of the mouth close to the left alveolar arch. As the patient was most unruly, I had ether given for a few minutes, while the vessel was secured. No further bleeding took place, but the patient never "came to" properly, dying about sixteen hours later. His lungs were the seat of old broncho-pneumonia, and his kidneys showed advanced fibroid change, but the additional shock of the hæmorrhage and some blood in his lungs were undoubtedly the causes of death. Broncho-pneumonia carried off the third and fourth cases. The fifth, the subject of long-standing and severe syphilis, died thirty-six hours after the operation. In this case I had unwisely removed epitheliomatous glands at the same time. The sixth, an old lady of 79, with extensive tongue cancer, died on the day after the operation, from debility and the impaired vitality which I removed a large papilloma of the posterior pharynx. She died with bronchitis. I much regret not having performed the operation.

(2) That this method of packing with gauze does not, and cannot, give absolutely reliable aseptic results. It would, I think, be easy to prove this from the constant soaking of saliva and other fluids, in which this wound differs from others, but no better proof can be given than the fact that a patient on whom Mr. Butlin himself made trial of this method died, on the eighth day, of infective pneumonia.

(iv.) **Trans-hyoid Pharyngotomy.**—As Mr. Careless advises (*Practitioner*, May, 1903, p. 661) this method in certain cases of growth involving the posterior third of the tongue, I have included it here. The cases he refers to are those of disease far back on the dorsum of the tongue, spreading towards the epiglottis but not involving the root of the tongue. He hopes that by this operation it may be possible to save the anterior portion of the organ. In my experience such cases are rare, the tongue being usually fixed and the disease generally infiltrating forwards as well as backwards. Where the severe operation of Syme or that of Langenbeck (p. 612) have been thought unsuitable on local or general grounds, I have usually left such cases alone, holding, perhaps too strongly, the opinion that with no surface cancer is it more essential to try and exercise a wise selection of cases than in these of the tongue, of which even the more favourable ones often come to us too late. It will be seen that there was no local recurrence after Mr. Careless's operation.

His patient, æt. 60, was admitted September 1, 1900. A "lump" had been noticed on the back of the dorsum of the tongue in January, 1900. The organ could be protruded fully, and there was but little discomfort in swallowing. Nothing was to be seen of the growth from the front. With a laryngoscope a large indurated ulcer invading the epiglottis, reaching forward from it for about one and a half inches, and more marked upon the left side than the right, could be seen. There was an enlarged gland beneath the left angle of the mandible.

September 4, the patient was operated upon by trans-hyoid pharyngotomy. A preliminary high tracheotomy was performed, a Hahn's tube inserted, and chloroform administered by this, a sponge being kept over the entrance of the larynx. The operation was performed on the lines given at p. 618. After separation of the geniohyoids and exposure of the hyoid bone this was divided in the middle line with bone-pliers. "The two segments were drawn apart by the retractors, and with a little undercutting a considerable interval was obtained, in which was exposed the middle thyro-hyoid ligament, and beneath it a pad of fat. Through these structures an opening was made with the knife just above the thyroid cartilage, and the base of the epiglottis was cut through a little above the false vocal cords. This opening was enlarged by scissors on either side by dividing the ligament and portions of the thyro-hyoid muscles, so as to enable the finger to be inserted, and thus the exact size and situation of the growth on the back of the tongue was readily defined. It was then merely a question of snipping with the scissors to take away the growth. Incisions were made in either side of the epiglottis, well away from the lateral margins, and thereby the segments of the hyoid bone were more easily separated, giving additional space to work in; next I removed a V-shaped segment from the back of the tongue including the whole of the diseased tissues, and this without encroaching on the main vessels and nerves, although the left hypoglossal was seen. The bleeding was very slight and readily controlled by ligatures. I drew the edges of the V-wound together at the anterior extremity, but behind it was too extensive for this to be undertaken. Three catgut sutures were employed in this way. The two halves of the hyoid bone were stitched together by a catgut suture passed through the periosteum. The central part of the wound was left open and a gauze plug introduced, the rest being closed with sutures." Finally a smaller Hahn's cannula was introduced. This was replaced by a tracheotomy-tube after forty-eight hours, the latter being removed on the tenth day. Five weeks after the first operation the glands on the left side were removed. Eighteen

months after the first operation the patient appeared free from recurrence, but a few months later the glands on the right side of the neck became enlarged.

(v.) **The Écraseur.**—This method has been condemned in the strongest terms by Sir. F. Treves (*Oper. Surg.*, 2nd ed. vol. ii. p. 199). As it has been used with much success by Mr. Hutchinson,* and as circumstances may, occasionally, arise which would justify its use, I have described it here.

In addition to the instruments already given in the description of the operation with scissors, the surgeon must be provided with a stout, short écraseur, curved on the flat working smoothly and carrying a strong loop of whipcord, not of wire.†

The first part of the operation resembles that given at p. 587. The tongue having been well drawn out with a silk loop, and the anterior pillar and the mucous membrane between the alveolar margin and the tongue cut through, the tongue is split with a bistoury along the raphé as far back as is needful, and its attachments to the floor of the mouth partly snipped through with scissors, partly torn through with the finger. The tongue being now freed sufficiently to make the transverse divisions, two slightly curved needles, in handles, are made to perforate the tongue a full inch behind the posterior limit of the disease, and the loop is then slipped on and adjusted behind the needles. Before doing this, I would strongly recommend that a deep groove be cut with the scissors through the mucous membrane of the dorsum and sides of the tongue; this simple step will serve to steady the bite of the écraseur and lessen the risk of its gradually coming, as it is tightened up, dangerously near the growth, and it will also shorten the time that the loop takes to effect its work. When first adjusted, the écraseur may be worked more quickly, but as soon as real resistance is felt the screw must be turned more slowly, a half or three-quarter turn being made every minute, or at longer intervals if the loop seems to be cutting too quickly. To avoid bleeding, and snapping of the loop, this tightened as it is, when once buried, must be very deliberate (Hutchinson), the operation taking from half an hour to an hour. If oozing take place from hurried use of the écraseur, it will be far more difficult to arrest on a surface bruised by this instrument than on one clean cut by scissors.

When the whole tongue is removed, the écraseur should always be applied to each half separately. Making the transverse section across the whole tongue at once is most tedious, and the great strain is likely to be too much for the loop or instrument itself. It also causes the constricted tongue to swell into a large livid mass, which much obstructs the breathing; and if, as is likely, both the linguals, which are left to the last, are divided simultaneously, the furious spiriting of these vessels in two crossing streams is most embarrassing (p. 600).

I do not recommend the use of the écraseur, for these reasons:

1. However well behind the disease the loop is placed at first (a step by no means easy to secure where the disease is situated far back), as it is slowly tightened up it tends to come forward (even when a

* Mr. Hutchinson's strong advocacy will be found in *Brit. Med. Journ.*, 1891, vol. ii. p. 1247. His success, it must be remembered, is largely explained by the facts that a great number of his cases have been partial excisions, and many of them operations on private patients. It is well known how persistently Mr. Hutchinson has advocated early operations.

† Mr. Butlin (*Dis. of the Tongue*, p. 334) gives the following case: The only instance of death from hæmorrhage "in my table occurred in the case of a man whose tongue was removed with a strong wire écraseur, which cut through the tissue of the tongue like a knife, much more quickly and cleanly than had been intended. There was some smart hæmorrhage at the time, and it was not easy to get the tongue to stop bleeding. The patient was alive. The artery was not thoroughly secured, sank and died a few hours later."

groove has been cut in the mucous membrane), gradually grinding the needles placed to keep it in position and the loop closer and closer upon the diseased area, or, if not actually into this, into one which, from its close contiguity, is ready to take on disease.

2. I have seen again and again, however carefully the tightening of the loop has been managed, that this is, finally, not fine enough to divide the lingual artery, which is dragged out in the eye of the loop, and has, after all, to be secured by ligature or torsion, often not without previous furious bleeding.

The *galvanic écraseur* has not been described. I mention it here only to condemn it. During the operation the loop may break, or it may cut its way too rapidly through the softened tissues, especially if the heat used be too great. Later on, the patient has still to run the gauntlet of the risks of infective lung-trouble and secondary hæmorrhage which the use of this treacherous instrument entails.

CANCER OF THE TONGUE AND OTHER PARTS AS WELL.

Question of Operation.—These cases, in which it is most difficult to decide aright, fall mainly into **two groups**.

A. Where the epithelioma is situated *far back*, affecting the tongue, tonsil, palate, and perhaps the posterior part of the body of the jaw.

Here the cancer affects a region very rich in lymphatics, and invasion of the glands will probably take place early. For this reason permanent successes are practically unknown here, though operations are, from time to time published as successes, often within a few weeks or months of their performance.

In deciding upon operation the surgeon will be guided first by the age of the patient, the natural expectation of life, the vitality and power of recovery, and the state of the viscera, especially the lungs.

Then he will investigate very carefully the following points: How far any fixity of the growth here points to involvement of the muscles at the root of the tongue, if the mandible is involved near its angle; how far the epiglottis or the upper aperture of the larynx is involved;* whether the secondary growth of the tonsil and its pillars is hard and fixed, or movable on the parts beneath; whether the pharynx itself is involved. Next, if there is enlargement of the lymphatic glands, their extent, fixity, and how far any softening or breaking down is already present.

In my opinion any of the above should usually decide against operation in these cases; and as to the glands, I will only say that here, and in all kindred cases, epitheliomatous enlargement in the posterior triangle, and especially of those under the upper third of the sternomastoid, renders operative interference hopeless as to permanent success.

In deciding upon an operation, the points fully dealt with in Chapter XI., p. 609 will be found helpful.

* Eucaïne or, where the mouth is partly closed, a general anæsthetic may be required to clear up this point.

Operation.—In these cases where the growth involves the tongue far back, and other parts such as the jaw, tonsil, palate, &c., the only steps that can possibly be adequate will be those taken on the lines of Langenbeck's operation or one of the methods of pharyngotomy given in the next chapter, according to the site and direction of extent of the epithelioma. The chief steps in Langenbeck's operation are the slitting of the cheek and the division of the jaw, steps which, while they provide good access to a growth situated far back, also emphasise the severity of the operation in the case of the lowered vitality often presented by these patients.

The patient is first brought fully under the anæsthetic, which is afterwards continued by a nasal tube. The cheek is split, the facial artery secured, and the incision then carried across the mandible just in front of the masseter into the submaxillary region, over which it is continued to meet the anterior border of the sternomastoid about the level of the hyoid bone. From this point flaps are raised sufficiently for thorough exposure of the submaxillary region. This is cleared out, the facial artery tied again low down, together with the lingual. The jaw is now sawn with a Gigli's saw obliquely downwards and forwards. As the section passes through the basilar border the saw should be turned still more forwards. The object of this oblique section is to lock the fragments together, there being a marked tendency for the anterior one to drop and the posterior to be raised. Before the saw is applied holes are drilled without disturbing the periosteum. This is next carefully divided. The section through the mandible should pass behind the last molar tooth. If the posterior belly of the digastric and the stylohyoid are now divided, the two halves of the jaw can be very widely separated, and the diseased area rendered accessible. The diseased parts are then removed by the knife or the cautery. The choice between them is referred to at p. 610. As the lingual artery will have been tied on one side the hæmorrhage will not be troublesome, or more than a watchful assistant can sponge away through the divided cheek. In this operation, as in lateral pharyngotomy, if the surgeon is in doubt as to the lower limits of the disease, by carefully fixing a hook in the epiglottis and lifting up the larynx he will be able to clear up this point. The jaw is wired and the wound closed in the usual way. If the patient's condition admits of it, the condition of the deep cervical glands must be investigated, otherwise this step is deferred for a fortnight. Adequate drainage must be provided. This and the treatment of the wound are referred to at p. 615. Where the mandible or the mucoperiosteum over it is infiltrated, part of the bone must be removed. If it be possible a strip of the basilar border must be retained, otherwise the sufferings of the patient and the difficulties of the after-treatment are much increased. On this point, where the vitality of the patient is unusually good, the case next related is encouraging.

B. In this group the epithelioma has attacked the chin and *fore part* of the tongue and the floor of the mouth. Here the outlook is better as to a permanent cure, owing to this part being farther from the larynx and less richly supplied with lymphatics.

All the affected parts must be removed unsparingly, and the resulting deformity may be very great.

Fig. 246 shows this well, and in

occasionally, when occurring on a superficial surface, and one which dries quickly, epithelioma ulcerates slowly for a time.

The patient, a man aged 33, had been originally operated on for epithelioma of the lip at a hospital in the South of England. The disease recurred, and gradually invaded the chin and symphysis menti, the front of the tongue, and the floor of the mouth. The case was a distressing one, on account of the large foul sore prominently in view, the filthy smell of the discharge, and the neuralgic pain constantly present due to the disease having involved both inferior dental nerves. The man had been seen by two other London surgeons, and operation had been advised against owing to the very small chance of a permanent cure, and the deformity which was certain to follow on the operative interference necessary. As no enlarged glands could be felt, and as the patient, young himself

FIG. 246.



and healthy otherwise, had a young wife and child, I left the decision to him, after putting the two sides of the question clearly before him. He decided to run the risks. At the operation, performed by curved incisions carried out from the angles of the mouth on to the cheeks, then across the submaxillary regions to the anterior border of the sternomastoid, and thence running inwards to meet at the hyoid bone, healthy tissues were cut through, but it was quite impossible to provide adequate flaps. It was necessary next to saw the jaw through just in front of the masseter on each side, as sections in front of this point showed that the inferior dental canals were invaded by the growth. While a finger in the mouth carefully defined the extent to which the floor and soft parts were invaded, as shown by the induration—no ulceration, happily, having taken place here—the diseased structures, including the anterior half of the tongue, were cut away with a wide margin of healthy tissue. All hæmorrhage having been arrested and drainage provided, either side was brought together as far as was possible. No epithelioma found. The patient made a good recovery, his chief trouble at first being inability to eat any food at all, which necessitated feeding him with a tube, and the pa-

sawn fragments moving in inflamed soft parts with any spasmodic action of the muscles. Now, June, 1906, eight years after the operation, he is free from recurrence. The chief drawbacks to his lot, in addition to the necessary deformity, are that he needs a tube for liquid food, that his power of speech is limited owing to the loss of his lower lip and the way in which the stump of the tongue is tied down in the scar, and the constant dryness of his mouth. He is able to work at home, making hen-coops and the like. His wife has borne him a second child. If he continues to have no recurrence of the growth, it might be possible to close in the gap by means of a flap taken from the arm.

Removal of Glands.—I have already, at p. 579, drawn attention to several points that are of the greatest possible practical importance with regard to the invasion of the lymphatic glands in epithelioma of the tongue. With regard to operations here two questions arise for answer:—A. Should a routine operation be performed for removal of the lymphatic glands in every case, just as in the operation usually performed for cancer of the breast, whether the glands can be felt or no? B. How far are later operations on the glands justified, in cases in which they are noticed to be enlarged some time after the operation on the tongue?

A. *The advisability of removing the glands in every case, as a matter of routine.*—I advocate this step very strongly on the following grounds:—(1) We can never tell in what cases invasion of the glands will follow. That it follows in a great number, and in many apparently most favourable cases, is certain. Mr. Butlin (*loc. supra cit.*, p. 543) puts the percentage as follows:—"About 70 per cent. of the cases can be so successfully treated by operation that there is little fear of recurrence *in situ*; but of these seventy persons probably thirty will die, perhaps as many as forty, of affection of the glands of the neck." 2. We do know (α) that infection of the glands begins here almost from the day that the ulcer assumed suspicious features. (β) that the same infection may be started by ulcers of the smallest size and of but brief duration. (γ) That deposits of epithelioma may here remain latent in the lymphatic glands for two years certainly, and then evolve disease. (δ) That gland infection is here not only certain, and often early, but peculiarly baneful (p. 579). 3. The neck is a part which lends itself readily to healing, and with scars that are ultimately not very disfiguring, especially in males.

For the above reasons exploration of the anterior triangle and removal of any enlarged glands should always be urged as a matter of routine on patients with cancer of the tongue, and especially in hospital patients, owing to the more advanced stage of the disease often met with in them.* By adopting this routine practice, no doubt, a few needlessly extensive operations will be performed, as in the case of the breast. But with cancer of the tongue, as with cancer of the breast, we do not know, and have no means of diagnosing, the few cases in which the glands will not become involved. Hitherto we have too much left the question to chance: the result has been that many most successful operations on cancer of the tongue have been rendered fruitless by the reappearance of cancer in the glands, which at the time

* When the operation is refused, the patient should, if possible, be kept under regular observation at short intervals.

of the primary operation appeared perfectly healthy. The operation should be performed about two weeks after that on the tongue, according to the severity of the primary operation and the recovery of the patient. Even greater thoroughness is required here than in the case of removal of tuberculous glands; the full details given at p. 717 for the removal of these should be referred to. It must suffice here to mention the chief guiding principles. Each sub-division of the anterior triangle, and all the groups of glands mentioned below, must be exposed in the fullest way. For this purpose an incision along the whole length of the anterior border of the sterno-mastoid, and a second passing up from this at the level of the hyoid bone to the chin will usually suffice. Where it is decided to explore the posterior triangle as well, or to divide the sterno-mastoid, a third incision must be made outwards, on the same level as the second, across the sterno-mastoid to the anterior border of the trapezius, or one from the lower end of the first outwards along the clavicle. Or Beatson's incision (p. 714) may be employed where it is decided from the first to open both triangles. But in this case, and where it is decided to divide or to remove part of the sterno-mastoid, the prognosis is extremely bad, owing to the number of minute glands already involved. In making the above incisions, no precautions as to the position and look of the scars are to interfere with obtaining the freest access to the disease. Here, even more than in tuberculous glands, the importance of the first operation and its thoroughness while the parts are unaltered by scar tissue, is to be remembered. Not only is every one of the groups of glands mentioned below to be investigated, and every gland that can be seen, whether enlarged or no, to be removed, but, in order to extirpate possibly infected lymphatics, the subjacent muscles are to be dissected clean, and all cellular tissue and fat cleared away. The internal jugular is again the chief landmark, but in this case there may be less hesitation in removing it between two ligatures. The chief groups of glands are to be removed, as far as possible, in one piece. Still greater precautions are needed here not to rupture infected glands or to cut into them prematurely where the neck is thin. Where this complication occurs, the precautions given at p. 719 must be assiduously followed. The operation is always a prolonged one, and therefore, in my opinion, to be undertaken separately fourteen days or more after removal of the primary disease. Where the tongue has previously been extensively removed this may cause some embarrassment with the anæsthetic. Chloroform is now the anæsthetic of choice. If necessary, the stump of the tongue must be kept forward with a ligature, and an efficient gag and sponges on holders must be at hand.

The three chief groups affected are the sub-maxillary, the sub-mental, and the deep cervical.* The sub-mental is often overlooked. The sub-maxillary group can only be extirpated by removal of the sub-maxillary salivary gland, as in this and on its deeper aspect lymphatic glands are often embedded. The condition of the deep cervical should be explored by following downwards the whole length

* Mr. Butlin (*Brit. Med. Journ.*, Feb. 11, 1905) adds that search should be made between the geniohyoids in case a gland lies here.

of the carotid sheath as far as it is accessible. I will add two hints about the glands here: one, that in investigating their condition before operation, the surgeon should stand behind the patient, and that the examination should be intra- as well as extra-oral. By this combined method, a gland lying on the hyoglossus can often be detected. The other is that infection of the glands on the side opposite to that of the growth of the tongue may be present, though unfelt. It may take place by means of lymphatics meeting in the tongue, or by the free communication which exists between the deep lymphatics of the two sides of the neck.

B. *Advisability of operating on enlarged glands at a later date, i.e., some time after the operation on the tongue.*—While this step must be taken sometimes, it is done under much less favourable conditions. There are few more difficult questions to decide than those which arise in these cases. The patient, maybe in the prime of life, with a soundly healed scar in his mouth, comes again to the surgeon, perhaps after a long disappearance, with infected cervical glands, and urges further operation. Each case must be decided upon its own merits. I will only urge the following upon my younger readers. 1. It is not the least use operating when the uppermost deep cervical glands are involved, *i.e.*, those under the upper third of the sterno-mastoid, where the muscle is firmly tied down by processes of deep cervical fascia, and where the glands extend to the mastoid process behind, and the angle of the jaw in front, and into the pterygoid region. 2. Operation will probably be futile (α) when any of the infected glands are soft and breaking down (p. 600); (β) when both anterior triangles contain enlarged glands.

After-treatment of operations on the tongue.—The chief objects here are: (1) to keep the wound as sterile as possible; (2) to give sufficient food.

I have already (p. 581) spoken of the importance of previous cleansing of the mouth, and teaching the patient to do this, and to feed himself.

After the operation the cut surface is brushed over with a strong solution of zinc chloride (gr. xx.— $\bar{x}$ j.), or Whitehead's varnish. This is a modified "Friars Balsam," a saturated solution of iodoform in ether being substituted for the spirit, and one volume in ten of turpentine being added. Ice is given to suck, and milk and brandy and beef-tea are administered either by a soft œsophageal tube or by enemata, or both. But I have generally found that, after the first six hours, a patient previously practised in the matter will give himself sufficient food, with a feeder and tube attached.* A glass of pale ale is, usually, early acceptable.

After the patient has had his first sleep the surface is brushed over, every two or three hours at first, with formalin, and he is soon encouraged to sit up and wash out his mouth constantly with carbolic acid (1 in 60 or 80), a wash of a tablespoonful of spirit of wine in a tumbler of water (Hutchinson), or Condyl's fluid. It is not the wash that is of so much importance as the frequency and painstaking with

* If this is not the case, a soft tube must be passed. Nutrient enemata are not sufficient.

which it is used. From time to time the stump is painted over with formalin, or Whitehead's antiseptic varnish. The patient should be kept warm and free from draughts, and propped up or turned on to either side alternately. I try to induce my patients to sit up a little on the second day if possible, and get them, when this is feasible, into an arm-chair a day or two later. Yolks of eggs, arrowroot, soups, pulped vegetables in broth, ale or stout, and such like, are, as soon as possible, taken in addition to the milk and brandy and beef-tea.

Causes of Failure.

In considering the deaths which follow soon after the operation, the effects of pre-existing bronchitis and emphysema, interstitial nephritis, aortic disease, and, sometimes, previous hæmorrhage from the growth may have to be remembered.

(1) Broncho-pneumonia. Abscess and gangrene of the lungs. Empyema. As these are infective in their nature, and due to the patient breathing foul gases and drawing down putrid fluids into his lungs, the treatment must be preventive, every endeavour being made to keep the mouth sweet and to relieve the patient's breathing by attention to the details already given.

(2) Hæmorrhage. This is rarely met with at the time of the operation or soon after, if every spiriting artery has been properly secured.

Hæmorrhage will also be rarely met with as a secondary complication if the wound has been kept sweet. In cases of bleeding, if the application of a silk ligature to the bleeding point taken up by a Spencer Wells's forceps or a tenaculum is impossible, firm pressure with a sponge and adrenalin chloride should be made use of after all clots have been removed. If the wound has been allowed to become foul, it must be cleansed by brushing it over with formalin (1 in 250), Whitehead's varnish, or, in the absence of these, with turpentine—a most powerful cleansing styptic,* and one always to be used in preference to perchloride of iron. If all the above fail, either applying and leaving *in situ* a pair of Spencer Wells's forceps, packed around with soft gauze, or ligature of the lingual, must be resorted to (*q.v.*).

(3) Cellulitis. Erysipelas. (4) Pyæmia. (5) Exhaustion—more rarely, shock. (6) Œdema of the glottis. (7) Suffocation from falling back of the tongue. (8) Reappearance. I have spoken fully of the gravity of this at pp. 579 and 605. For the first year after the operation every patient should come under skilful supervision at intervals of a month and no longer.

The steps already detailed of the different operations on the tongue will suffice for the rare cases of **sarcoma**. For fuller information I will refer my readers to an article by Sir A. Fripp and Mr. Swan (*Practitioner*, May, 1903, p. 673). The following are the directions for treatment: "One point which appears to be very emphatically demonstrated by the cases which we have collected is that these tumours should be *widely* removed by an incision into the healthy lingual tissue well clear of the growth; for although the ease with which the obvious

* See the remarks on a case of ligature of the occipital artery. If the bleeding is of the nature of oozing, solution of adrenalin and one or two injections of ergotin should certainly be tried.

new growth can sometimes be enucleated is very tempting, yet such a method of separation from the surrounding compressed tissues is extremely liable to be ineffectual in removing all traces of the growth, the pseudo-capsule remaining will contain the nucleus for a recurrence at a later date. The question which method of operation is most applicable depends on the nature of each individual case, and among other things on the situation and volume of the tumour. Small tumours of the anterior part can be attacked from the mouth; those placed in the middle third of the tongue can be more easily reached by dividing the cheek; but those cases in which the growth has extended downwards in the muscular attachment of the tongue, whether projecting in front of or behind the circumvallate papillæ, demand a suprahyoid incision, opening up the floor of the mouth or the pharynx as the case demands. If recurrence should ensue the secondary tumour must again be removed, and widely."

CHAPTER XI.

OPERATIONS FOR GROWTHS OF THE TONSIL, FAUCES, BASE OF TONGUE AND PHARYNX.

THE new growths here are most commonly round-celled sarcomata and epitheliomata.

In sarcomata, in adults, there is a steady enlargement of one tonsil, without, at first, pain or inflammation; a globular swelling, the size of a walnut, appearing firmly elastic, tending to infiltrate adjacent structures, and fungate as a sloughing mass into the mouth.

In the epitheliomata the patients are older; the mischief often begins as "a sore throat." The mass occupying the site of the tonsil is now much harder, and soon ulcerates, forming an excavated ulcer with the characters of epithelioma, and soon implicating adjacent parts. The base of the tongue may be involved secondarily. Dysphagia, emaciation, &c., are more rapid here.

Before describing any operations for removal of tonsillar growths, it is right to allude to their great malignancy, owing to the rapidity with which the glands are affected both in epithelioma and most of the sarcomata. In this, rather than in the importance of its relations, lies the failure of operations on the tonsil, and no one who has watched the rapidity with which (owing to the intimate connection between the tonsil and the lymphatic glands) enlargement of the glands at the angle of the jaw takes place in subacute tonsillitis will wonder at this. Diagnosis at the earliest possible moment is of the greatest importance here.

Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 176) writes on this malignancy: Sarcoma of the tonsil "proves fatal, in very many instances, within a year or even six months of its first appearance; indeed, few persons survive for more than three-quarters of a year."

Dr. Newman (*Malig. Dis. of Throat and Nose*, p. 176), writing of sarcomata of the tonsil, draws a distinction here which may have some practical importance. While admitting that round-celled sarcomata, by far the most common variety, quickly invade the glands, he points out that the spindle-celled sarcomata may remain limited within a capsule, and so be capable of complete removal. Thus, in one case of Dr. Newman's the patient lived five years after removal of a spindle-celled sarcoma through the mouth, and then died rapidly owing to disease appearing in the opposite tonsil.

Operations.

- | | |
|-----------------------------|-----------------------------------|
| A. Through the Mouth. | C. Combined Operations. Through |
| B. By Incision in the Neck. | the Mouth, by slitting the Cheek, |
| Lateral Pharyngotomy. | and Lateral Pharyngotomy. |
| | D. Median, or Trans-Hyoid Pharyn- |
| | gotomy. |

Whichever method is chosen, the selection of cases here for operation must be a very careful one, owing to the great malignancy of these growths, and the advanced stage which the disease has often reached; even in these regions, we often hear the statement that the patient suffered very little inconvenience in the earlier stages.

CASES FAVOURABLE FOR OPERATION.—Where the growth is still small, localised to the touch, well defined, still movable, free from ulceration, and where no enlarged glands can be made out. On the other hand, where the swelling in the mouth is continuous with one in the neck, each diffuse and ill-localised, and the primary growth showing a friable, sloughy, ulcerated surface, operation will be contra-indicated. Gastrostomy, as a palliative step, may here give some relief. In intermediate and doubtful cases, as where one or more enlarged glands exist, but still separate and mobile, the surgeon will be justified in giving his patient a chance, knowing the distressing future if the growth be left—the agonising earache, the dribbling of foetid saliva, the dysphagia, &c. The following points require particular attention. Here, especially, is it true of malignant disease, that the mischief is liable to be found more extensive than was thought to be the case before the operation. Owing to the danger of infective pneumonia the presence of any bronchitis is against operation. And the same may be said of cases where there is any fixity of the jaw, as this suggests extension along the connective tissue between the pterygoid muscles. Owing to the difficulty in feeding the patient—and rectal feeding alone will be quite insufficient—the vitality of the patient, and his amenability to directions, must be estimated beforehand. The more the growth encroaches on the orifice of the larynx the greater the risk of broncho-pneumonia and œdema glottidis. The frequency with which the glands are early implicated has already been referred to.

A. Through the Mouth alone.—This method can only be made use of rarely, as in a very early stage of tonsillar new growths, when the disease is limited to the tonsil itself, not implicating the adjacent pillars, and when there is not the least evidence of glandular enlargement. Dr. Newman's case, referred to above, justifies occasional resort to it.

If the following operation seems somewhat severe, the infiltrating tendency of growths here must be remembered.

The surgeon having decided the question of a preliminary laryngotomy* (p. 614), the patient's head is suitably raised and supported, in a good light, and the cheek on the affected side divided from the angle of the mouth to the masseter, the two ends of the facial artery being secured. The mouth is now kept widely open by a gag inserted on the opposite side, the tongue drawn out of the mouth, and the masseter pulled backwards by a retractor. As much room and light as possible being thus obtained, the surgeon divides the soft palate first in the middle line, and then from within outwards with scissors; he next, either with the same instrument or with a blunt dissector and

* While I advocate this step and plugging the fauces in all cases, it should certainly be taken in those cases where the growth encroaches upon the back of the tongue, and where the patient has had any bronchitis. By its adoption one object of slitting the cheek, viz. getting the blood away quickly from the upper aperture of the air passages, is removed. The tube is, usually, taken out at the close of the operation (footnote, p. 614).

his nail, dissects around and carefully extirpates the tonsil with the pillars. The whole operation should be slowly and deliberately carried out, the surgeon cutting wide of the growth and encroaching on the tongue, &c., if needful. He thus removes the growth together with a margin of healthy tissue, and gives his patient the best chance. As pointed out above by Dr. Newman, some sarcomata here are encapsuled, and can be shelled out. Recurrence is, unfortunately, not less probable after this step (Butlin, *loc. supra cit.*, p. 175). The method of removing widely is far preferable. Bleeding will be best arrested by temporary forci-pressure and firm sponge-pressure.

Some surgeons do the whole operation with the cautery instead of the scissors. In this case the cautery must be used at only a dull red heat for fear of hæmorrhage. The surgeon must be prepared for its leaving indurated tissues which may simulate deposits of growth, and for the tendency of the instrument, as it is quickly cooled down by its contact with succulent tissues, to stick to them. A little additional heat frees it at once, far more satisfactorily than pulling it away. The objections to the cautery are—(1) that it requires a special instrument, which may not be at hand; (2) if it destroys an infected surface, it also introduces infection and risk of secondary hæmorrhage; (3) with it, it is very difficult to judge aright of the nature of the surfaces divided, whether sound or infiltrated; (4) it necessitates the use of chloroform, which may be inconvenient. For these reasons the use of the cautery, if it be employed at all, should be limited to searing thoroughly the surface of the wound, and I consider the use of a strong solution of formalin (pp. 436 and 451) preferable.

On the other hand Mr. Watson Cheyne considers the thermocautery the best means of removing an epithelioma of the tonsil and fauces, for these reasons. There is little bleeding at the time and, as this method destroys any infected epithelioma spreading superficially, it probably gives an additional safeguard against reappearance of the growth. The cautery leaves a surface from which there is much less discharge in the earlier stages than there would be from a clean-cut wound. The area to be removed should be first marked out by the fine point, as by this step the surgeon can make quite sure of removing the disease completely when the tissues become subsequently unrecognisable from the burning. Any glands which require removal are best dealt with first, immediately before the operation in the mouth, the wound being sutured and protected with gauze during the operation in the mouth. As the edges of a cautery wound cannot be sutured, he only recommends this method for small growths situated away from the larynx and not requiring an opening into the pharynx.

The case of small growths of the tonsil accessible from the mouth having been considered, that of malignant disease situated or extending lower down will next be referred to. I shall suppose that the glands require investigation, but that there is no softening or adhesion of these to the soft parts overlying them or to the pharynx.

The following courses are open to the surgeon:

B. Lateral Pharyngotomy. **C. Lateral Pharyngotomy combined with division or partial resection of the mandible, with one through the mouth, by slitting the cheek, or with Langenbeck's operation** (p. 601). **D. Median, Sub- or trans-hyoid Pharyngotomy.**

B. Lateral Pharyngotomy.—The glands having to be dealt with an incision is made along the upper half of the anterior border of the sterno-mastoid—it may have to be extended to the sternum—and a second carried forwards from this at the level of the hyoid bone curving upwards to the mandible to one side of the chin. The sub-mental group of glands is rarely involved in these cases. The skin, platysma and fascia having been divided and the external jugular, occasionally, secured, the flaps are dissected up and down and wrapped in sterile gauze. The facial vessels are next divided between ligatures and the sub-maxillary salivary and lymphatic glands cleared out. If the glands are extensively involved the incision along the sterno-mastoid must be extended to the sternum and the deep cervical group extirpated with the precautions given at p. 604. The operator now decides according to the vascularity and extent of the primary growth whether he will deal with the external carotid by ligature and extirpation of its branches (ligature of external carotid), or whether he will be satisfied by tying, close to their origin, such branches as the lingual, the ascending palatine (if not already secured by the ligature of the facial) and the ascending pharyngeal. This question is considered a little later (p. 613). The further steps in exposure of the pharynx are division of the muscles which overlie it, the digastric and stylo-hyoid first, then the stylo-glossus and stylo-pharyngeus, and the mylo-hyoid and hyoglossus as far as may be necessary. The hypoglossal, gustatory and glosso-pharyngeal will be in the upper part of the wound and the superior laryngeal nerve in the lower. All, especially the last, are to be spared when possible. The pharyngeal wall is now exposed. With the aid of a finger in the mouth, or slitting the cheek, the growth is now removed with as free a margin as possible with scissors. If the vascularity of the growth or other conditions seem to require the use of the cautery the surgeon must remember the difficulty which this method entails in estimating the condition of the tissues left after its use.

Question of Closure of the Pharynx.—This very important matter must now be referred to. Immediate closure with sterilised catgut in one or two layers, care being taken not to allow any inversion of the mucous membrane, has the advantage, if the sutures are sufficiently close and if they hold, of diminishing very largely the escape of infected discharges from the pharynx, and of facilitating the swallowing and feeding of the patient. This step is strongly recommended by Mr. Watson Cheyne. On the other hand owing to the stitches very rarely holding here as in the case of the œsophagus (*q.v.*), escape of the above discharges into the deepest part of the wound and a most dangerous cellulitis has not infrequently followed suture of the pharynx, especially when this has been followed by suture of the superficial incisions. I advise that the upper part only of the opening in the pharynx be sutured, a drainage-tube inserted here, the wound lightly plugged with a strip of sterile gauze, and a few sutures of stout salmon gut or of silver wire inserted in the flaps so that these can be partly drawn together when the deeper part of the wound is safely closed. As feeding of these patients by the mouth is imperatively needful, an additional precaution taken by some is to pass a soft tube by the nose below the wound in the pharynx. To prevent this being vomited when the patient is recovering from the anæsthesia, or when

he is restless and unamenable, the tube may be sutured to the mucous membrane of the pharynx with catgut. But this step, while it meets any difficulties in the frequent passage of the tube, prevents its being boiled after each feeding. In my experience the passage of a soft tube at intervals is generally preferable. Where the opening in the pharynx is too large for suturing, or where the cautery has been employed, plugging with gauze both of the deep and superficial wounds must be resorted to. V. Bergmann's suggestion to suture the edges of such a gap to those of the skin wound appears to me to have disadvantages which outweigh the advantages. It certainly allows the discharges, usually abundant, to escape freely, and the patient can be fed by the fistula thus formed. But where the gap in the pharynx is large it will be by no means easy to draw the deep lying edges of this up to the skin, and the subsequent closure of the wound will present difficulties.

C. We will now consider cases where the growth is situated higher up and further back, and an ordinary lateral pharyngotomy is not sufficient for its exposure. This is afforded by division or resection of part of the mandible. The preliminary steps are the same as those already given, the upper end of the first incision (p. 611) being carried further back, and the upper flap dissected higher up. When the mandible is exposed and the submaxillary region cleared out the bone is divided in front of the masseter with a Gigli's saw (p. 361), the section being made obliquely so that its line encroaches more upon the outer and lower aspect of the bone than upon its inner and upper, because the sawn extremity of the posterior fragment has a tendency to pass inwards and upwards (Kocher). Before the saw is used, holes should be drilled for the passage of the uniting wire. The two halves of the mandible are now drawn forcibly apart, the displacement of the anterior fragment being aided by free division of the posterior belly of the digastric and the stylo-hyoid. Where, owing to the extent of the growth, mere division of the bone and separation of the fragments will not give sufficient room, the mandible should be divided obliquely just behind the angle and the ascending ramus removed by disarticulating the condyle. The muscles must be detached, including the posterior part of the masseter, and the inferior dental artery ligatured. If the angle is left, a precaution always to be taken, the above resection, while giving good access to the disease, will be found to give satisfactory results as to subsequent mobility of the jaw and disfigurement.

The above methods apply chiefly to growths involving the parts about the fauces; where it is chiefly the region of the orifice of the larynx that is encroached upon, viz., base of tongue and epiglottis, these parts can be exposed by a lateral pharyngotomy which opens the pharynx further forwards, and removing the great cornu of the hyoid bone. As this course runs additional risk of causing injury to the superior laryngeal nerve, and thus an insensitive condition of the larynx, and as cases involving the epiglottis are the most unfavourable of all owing to the especial risk of aspiration-pneumonia, if any operation is performed, it should be a median or trans-hyoid pharyngotomy (p. 618).

The after-treatment will be similar to that given at p. 605 and 6

Choice of Operation.—Where the growth is no longer quite

where it is not limited to the tonsil itself, where there is any enlargement of glands, or where the existence of this, though not certain, is, from the duration of the case or the presence of ulceration, very probable, lateral pharyngotomy, with or without incision of the cheek, should be performed. It gives free access to the tonsil and adjacent parts, it enables the surgeon to have the important vessels of the neck retracted, it admits of a simultaneous removal of enlarged glands, and putting a temporary loop upon the common carotid (*q.v.*), or ligature of the external carotid, or trusting to securing the facial and lingual close to their origin, whichever course be preferred. On the other hand, this operation is a severe one. The jaw, if divided, must be wired, and necrosis of the bone or non-union may follow. For it must be remembered that this wound cannot be an aseptic one, and the opening in the pharynx, especially if this has been made by the cautery, may set up septic infection in spite of drainage. The following words of Prof. Kocher on the extent of operation probably required are weighty ones: "We would warn our readers especially against attempting to operate from the mouth in those common cases of carcinoma situated at and behind the isthmus of the fauces, and spreading on to the epiglottis, and involving the soft palate and lateral wall of the pharynx, because, in cutting wide of the diseased tissues, one cannot avoid doing a serious injury to adjacent parts and dividing large arteries. If the carotid is wounded in adherent indurated tissues, there is a great risk of not being able to arrest the hæmorrhage quickly enough, whereas from outside one can control the large vessels with much greater certainty. If the new growth involving the tongue and pharynx has extended to the fold between the jaws and the bone itself, it is best, after dividing the lower jaw as above described, and separating the capsule of the joint and the external pterygoid, to disarticulate and remove the ascending ramus, after detaching the healthy muscles, including the masseter. In this way subsequent closure of the jaw is most certainly avoided." Cases involving the epiglottidean folds or their neighbourhood are the most unfavourable of all owing to especial risk of aspiration-pneumonia.

Possible Aids in the above Operations.

1. *Ligature of External Carotid.*—At first sight this step, which ensures very little bleeding, a clear field of operation, and absence of anxiety as to blood entering the larynx, seems one of universal application. But again, the fact that the wound may become infected renders mere ligature one of risk. With the pharynx opened in the neck, or a laryngotomy or tracheotomy performed, and the tube, if necessary, retained, infective softening and ulceration about the ligature may occur with fatal secondary hæmorrhage. Thus Mr. Watson Cheyne lost a patient twenty-five days after an extensive operation for epithelioma of one tonsil (*Objects and Limits of Operations for Cancer*, p. 59). He states that Polaillon, who has tied the external carotid in most of his cases, has lost several from this cause. Mr. Cheyne is inclined, therefore, only to make use of ligature of the external carotid when the operation is performed in two stages*—viz., removal of the enlarged

* adopted this plan, a week intervening between the leading from the deeper parts than if the external

glands and ligature of the external carotid first, and, about a week later, removal of the growth in the throat.

Primary and secondary hæmorrhage alike will best be met by adopting Dawbarn's method of excising the external carotid and its branches (see ligature of this vessel).

2. *Question of a Preliminary Laryngotomy or Tracheotomy.**—The objections to this step are obvious. It introduces another and necessarily infected wound; it is the means of colder air being introduced; it interferes with coughing and emptying the upper air-passages, an interference already brought about by the wound in the pharynx. On the other hand, this course has manifest advantages which are thus put by Mr. Watson Cheyne (*ibid.*, p. 71): "Where an attempt is made to remove the tumour without division of the jaw, or without ligature of the external carotid, and where the mass fills up the throat, and more especially where it runs down towards the entrance of the larynx and on to the tongue, the necessary manipulations cannot be carried out without interfering with the breathing, and exciting so much effort on the part of the patient that there is a very great risk of septic discharge and blood being drawn into the lungs; and besides, it is very necessary in these operations, in order to ensure that the disease is removed as thoroughly as possible, that there should be no haste in their performance, and that the surgeon should be able to see exactly what he is doing. Some prefer to do the tracheotomy three or four days before the major operation, but I fail to see the advantage of this: on the contrary, it must be remembered that after three or four days the discharge from the tracheotomy wound has become more or less septic, and consequently in introducing a big tube, such as Hahn's, some of the pus may be pushed before it into the trachea. . . . Preliminary tracheotomy is by no means an absolute safeguard against septic pneumonia, and I should be inclined to try and do without it where the disease is high up, or where it is behind the tonsillar region, and where the base of the tongue or the neighbourhood of the glottis are not interfered with. Where the base of the tongue is interfered with, the patient does not swallow nearly so readily as where this is not the case, and consequently discharges are apt to accumulate about the orifice of the larynx, and so get down the trachea. Hence, in these cases, I think that it is well not only to perform preliminary tracheotomy, but also to go on with Hahn's tubes for some days after the operation, till in fact the patient has, to some extent at any rate, regained the power of easy swallowing." The nearer to the larynx

carotid had just been tied" (*ibid.*, p. 67). Mr. W. Cheyne only advises that the operation be performed in two stages in cases where the patients are weakly, and the primary and glandular disease both extensive, and perhaps, also, where ligature of the external carotid appears to be desirable. He points out a serious objection to this method of operating—viz., that after removing the glands, open lymphatic vessels are left which may contain or convey cancerous material to the newly-made wound, and thus infect it before the second operation.

* While, in my opinion, a laryngotomy is always to be preferred when possible, it may be needful, in some of these cases of lateral pharyngotomy, to perform a high tracheotomy instead, as by this step the anæsthetist is less in the way of the operator. In either case, the tube should be removed as soon as possible, but owing to the risk of œdema of the glottis, it must always be kept at hand (*vide infra*).

that the growth extends, the more emphatically is a laryngotomy or a tracheotomy with its additional risks required. And more than this, the longer will the tube need to be retained, owing to the risk of œdema of the glottis. This risk is present during the first fortnight, and if the tube has been removed early, it must always be kept at hand.

3. *The Trendelenberg position.*—Where a preliminary laryngotomy or tracheotomy have not been performed, this may be tried after the first part of the operation when the glands have been removed. It has been strongly advocated by Prof. Keen, of Philadelphia, in all severe operations affecting the larynx. At the time of the operation its liability to cause venous congestion must be remembered, and its maintenance afterwards, on which Prof. Keen lays stress, is difficult owing to the tendency of the patient to slip down against the head of the bed. This may be obviated, in part, by flexing the knees over an inclined plane. Like a laryngotomy or tracheotomy, it, of course, cannot be relied upon to entirely prevent the occurrence of aspiration-pneumonia.

4. *The use of Eucaine.*—This is worth remembering in the deeper stages of these operations, especially those carried on near the orifice of the larynx. By the smaller quantity of general anæsthetic thus required the amount of bleeding at a trying time may be lessened.

After-treatment.—The same precautions as after removal of the tongue must be taken for keeping clean the wound in the mouth and neck. At the close of the operation a solution of zinc chloride (gr. 40-50), one of strong formalin, or Whitehead's varnish is applied. The treatment of the wound in the pharynx has been referred to above, the patient very frequently washing it out by one of the fluids given at p. 605. The patient should have practised gargling out his mouth and fauces beforehand (p. 581). In order to prevent the frequent soaking and changing of the dressings as much as possible, he should use small quantities, and hold his head on the opposite side. It will probably be well to retain one drainage-tube *in situ* for a week or ten days. This has been objected to on account of the danger of erosion of the external carotid. This may be prevented by dealing with the vessel as advised at p. 614. In any case the risk of insufficient drainage is far greater. It should be taken out and boiled before re-insertion, daily. Feeding by aid of a soft tube passed along the sound side will be needful for some time, perhaps as long as two or three weeks, where removal of the parts around the tonsil, the wall of the pharynx, or the base of the tongue has been extensive. The patient's feeding himself should be forbidden as long as any attempt at this causes choking or coughing, owing to the danger of fluids entering the air-passages. During feeding a pad of gauze should be placed over any opening in the neck. Mr. Watson Cheyne has found it useful to keep the patient's head hanging over the side of the bed and turned towards the sound side, the liquid being taken in small amounts and very slowly. As after removal of the tongue, the patient should sit up and be got out of bed as soon as possible.

Median Pharyngotomy.—As this form of pharyngotomy has been but little performed in England, and as it is highly spoken of by Prof. Kocher, I have described below in full the different methods which

he recommends, viz., *Sub-hyoid Pharyngotomy* by a free transverse incision, and *Median Pharyngotomy* by a T-shaped incision, by which not only is a growth of the pharynx but part of the larynx as well removed (Stiles's Trans. of 4th German ed., p. 121). I have also added, because I believe that it gives a better exposure of the parts, the French method of trans-hyoid pharyngotomy, in which a vertical incision is made and the hyoid bone divided. In my experience, the last, aided if needful, by division of the thyroid cartilage, gives sufficient room for dealing with growths of any extent which it is advisable to attack. The first two will enable the surgeon to remove a foreign body, and to deal with growths of more limited size.

"*Sub-hyoid Pharyngotomy*, introduced by Malgaigne and Langenbeck, deserves special attention. By utilising all the advantages of this procedure, the operation becomes much more frequently indicated than former authors supposed. It has the advantage of giving excellent access with little injury to the surrounding structures. Not only is the operation indicated for the removal of all growths situated at the entrance of the larynx, *e.g.*, growths involving the epiglottis, aryteno-epiglottidean folds, arytenoid cartilage, mucous membrane at the level of the hyoid bone, and of the sinus pyriformis, but equally for growths situated at the root of the tongue, and on the lateral and posterior walls of the pharynx as far down as the œsophagus.

"We have found preliminary tracheotomy and packing unnecessary; blood can be prevented entering the larynx by having the patient in the correct oblique position. A general anæsthetic can be dispensed with, and instead, a 1 per cent. solution of cocaine can be injected for the skin incision, and 5 to 10 per cent. solution can be repeatedly painted on the mucous membrane.

"The incision, four inches long, is made along the hyoid bone from the greater horn on one side to that on the other, dividing the skin and muscular fibres of the platysma. The hyoid bone is then exposed and the anastomosis of veins crossing it are ligatured. The hyoid artery and vein lie on the bone, and are retracted to the upper side of the wound. The muscles inserted into the lower border of the hyoid bone are divided at their insertions.

"The thyro-hyoid membrane is now exposed. The central part appears as a broad tense ligament, but the lateral parts are thinner. The central portion, which encloses fat and often a bursa, is transversely divided along the bone. The mucous membrane is similarly divided, giving rise to some spouting from small vessels. We do not consider it advisable to divide it at a distance from the hyoid, on account of the superior laryngeal nerve, which enters the larynx by piercing the lateral part of the thyro-hyoid membrane. If the twigs of the nerve are cut, the larynx becomes insensitive, and allows of the entrance of food, mucus, and wound secretions into the larynx. As these foreign bodies cannot be reflexly coughed up aspiration-pneumonia is developed.

"The epiglottis can now be seized with a hook at its upper border and drawn forwards. This gives an excellent view of the entrance of the larynx, especially the neighbourhood of the arytenoid cartilages, which is so often the seat of disease (tuberculosis and cancer), and also of the lowest part of the pharynx and the root of the tongue. If the

epiglottis must be removed, it is seized with a hook at its lowest point (which can be easily felt above the dip in the thyroid cartilage) and dragged outwards. After the mucous membrane has been divided it can be easily pulled out and cut away. As in laryngotomy, the reflex irritation of the mucous membrane must be quieted by frequent applications of a 5 per cent. cocaine solution, so as to enable the operation to be continued in comfort.

"The new growth should be thoroughly removed with the thermo-cautery, the parts being clearly exposed to view. The cautery arrests all oozing, and gives a better chance of a radical cure. As regards after treatment, it is well under certain circumstances to perform tracheotomy to avoid the danger from œdema glottidis, which often develops in an extremely insidious way, and may cause danger from asphyxia. The main wound is dressed with iodoform gauze and collodion. We used formerly to stuff the wound, but we have now abandoned the practice. As we always cut round new growths with the fine blade of a thermo-cautery and carefully stop all bleeding, we have found it sufficient to insist that the patient must lie with the head low whenever he is recumbent; but he should be allowed to sit up very early, to allow of easy expectoration of the secretions of the wound.

"We avoid, wherever it is possible, performing secondary tracheotomy. It is only when the sensitiveness of the larynx has been destroyed by injury to the superior laryngeal nerve that one cannot trust to the cough-reflex to prevent secretions from flowing down.

"*Median Pharyngotomy.*—Owing to the extreme frequency of tumours, especially carcinoma, in the region of the entrance of the larynx, *i.e.*, affecting one of the ary-tænoid cartilages and the ary-epiglottidean folds, and infiltrating the lateral wall of the pharynx and the sinus pyriformis, it is advisable to give a definite description of the method of exposing the lowest part of the pharynx with the least destruction of the parts.

"Just as we have lately, on principle, employed a median incision for the tongue and upper part of the pharynx, we have similarly restricted the use of lateral pharyngotomy in favour of median pharyngotomy, for cases of carcinoma such as those for which we have frequently been called upon to operate, and the results have been thoroughly gratifying as regards its precision and the minimum damage done to the surrounding structures.

"The incision is made, as in sub-hyoid pharyngotomy, along the lower border of the hyoid, but extending farther outwards on the diseased side, and only about $1\frac{1}{2}$ inch across the middle line on the healthy side. From this another incision is carried down to the thyroid and cricoid cartilages in the middle line as far as the isthmus of the thyroid, care being taken to avoid the vertical veins; the transverse veins are ligatured as in median laryngotomy.

"On the diseased side the sterno-hyoid, thyro-hyoid, and omo-hyoid are divided parallel to the hyoid, and the subjacent thyro-hyoid membrane is cut across as described in sub-hyoid pharyngotomy; the tip of the epiglottis is then seized with a small sharp hook and dragged forwards and towards the healthy side.

"The extent of the new growth anteriorly is now defined, and the epiglottis is divided $\frac{1}{2}$ cm. in front of the disease along its lateral

border down to its base. By this means a better view is obtained, and one is able to decide how much of the cartilaginous plate of the thyroid will have to be excised. The thyroid cartilage is then split in the middle line, and the muscles attached to the wing of the thyroid cartilage are separated, along with the perichondrium, from the diseased side. With a sharp hook the wing of the thyroid on the diseased side can be sufficiently drawn outwards and downwards to enable the tumour to be detached from below and then from behind, and the mucous membrane to be divided in healthy tissue in the region of the arytenoid cartilage (it is often necessary to divide it between the arytenoids). The new growth is now grasped by the fingers, and the limits of the hardness examined with sufficient exactness to decide where the soft parts (the muscular attachments of the pharynx) are to be divided from the outside. The limits of the mucous membrane towards the pharynx are clearly exposed, and the removal of half or so of the larynx along with part of the pharynx can be carried out, the bleeding being easily controlled and the diseased tissues completely removed.

"In this operation, just as in simple sub-hyoid pharyngotomy, we dispense with a preliminary tracheotomy by operating with the patient in the sloping position, and we use cocaine in preference to chloroform.

"As will be gathered from the description, we get at the lateral and posterior walls of the pharynx by adding to the incision parallel to the hyoid the median incision with splitting of the thyroid cartilage. This allows one-half of the larynx to be powerfully pulled downwards and forwards."

Trans-hyoid Pharyngotomy by a Vertical Incision (Vallas, *Rev. de Chir.*, May, 1900).—Of what I believe to be the advantages of this method in the case of growths of the pharynx about the base of the tongue and orifice of the larynx, I have spoken at p. 612. A case in which it enabled the operator, Mr. Careless, to deal with a growth situated far back in the tongue has been referred to at p. 598.

Operation.—An incision is made through the skin and subcutaneous tissue, in the middle line from the symphysis to the top of the thyroid cartilage. The raphe of the mylo-hyoid is carefully divided, the hyoid bone exposed exactly in the middle line, and divided with narrow sharp bone-forceps. The two halves of the bone, together with those of the mylo-hyoid and the genio-hyoids are well retracted. This affords a space of about one and a half inches in width. According to the site and size of the growth further access must be obtained by dividing the mucous membrane above and the thyro-hyoid ligament below. The operator now inserts a finger by the opening to feel the size and site of the growth; another introduced by the mouth will aid this. Cleaning of the fingers will not be forgotten before further proceedings. The epiglottis is drawn forwards as advised (p. 616), and excised with the growth by a V-shaped incision if possible, as this can partly be sutured at the upper part with sterilised catgut. If the epiglottis is clearly not involved, it is dissected free and left. The wound is carefully packed with gauze, which is brought out at the lower angle, sutures being only employed above.

Numerous details, already given, have been omitted here. A preliminary tracheotomy will be required owing to the manipulations

about the upper aperture of the larynx. The risk of subsequent œdema glottidis (p. 614) must not be forgotten. It would probably add to the after safety of the patient if, before the pharynx is opened, the Trendelenberg position were adopted. The patient must be fed at first with a soft tube.

Lateral pharyngotomy has an apparent advantage over the median method in that the incision for the former operation, if added to, admits of removal of infiltrated glands at the same time. For my own part, I am strongly of opinion, with all deference to that of Mr. W. Cheyne (p. 613), that it will be much wiser to remove the glands by a second operation, as has been advised in the case of epithelioma of the tongue (*q.v.*). An operation with the object of extirpating all the glands which may be affected (not only the group which can be felt), is sufficiently trying both to patient and surgeon to require a time for itself.

CHAPTER XII.

OPERATIONS ON THE AIR-PASSAGES IN THE NECK.

DIFFERENT FORMS OF LARYNGOTOMY—THYROTOMY*— LARYNGOTOMY OR INTER-CRICO-THYROTOMY— TRACHEOTOMY—REMOVAL OF FOREIGN BODIES IN THE BRONCHI—EXCISION OF THE LARYNX.

THYROTOMY.

Indications.

(i.) Growths which cannot be removed through the mouth, but which do not require severer operations on the larynx itself. The following are the chief conditions which must decide the removal of laryngeal growths by an operation from the mouth or by thyrotomy:

(a) The amount of special laryngeal skill possessed by the operator. (b) The nature of the growth, whether multiple or no, if pedunculated, if recurrent after attempts at removal from the mouth. (c) The extent of the growth. (d) The irritability of the larynx. The amount of self-control of the patient. Any tendency to asphyxia. While the much rarer fibromata are to be remembered, it is to papillomata in children that the following remarks apply.

It must be confessed that for laryngeal papillomata there is at present no really satisfactory treatment. When the usual age, the depth and small size of the parts concerned, the inseparable interference with respiration increased by any manipulations, and the obstinate tendency of moist papillomata to reappear elsewhere, especially in a concealed mucous tract such as the urethra, it is no wonder that any operative interference here must be uncertain.

Writing as I am for the younger generation of general surgeons only, I shall assume that endolaryngeal interference is not available or that it is not to be entertained from the age of the patient, the history of dyspnœa, or the marked degree of aphonia which points to the growths having reached an extent which may at any time bring on sudden and

* For the sake of accuracy the following should be distinguished when the terms "laryngotomy" or "thyrotomy" are employed:—(i.) *A complete laryngotomy* or division of the larynx, both thyroid and cricoid cartilages and the crico-thyroid membrane, as in cases of early malignant disease where full exposure of the parts is essential (p. 660) (ii.) *A partial laryngotomy* or division of the larynx where the crico-thyroid membrane and the cricoid, or the thyroid cartilage are alone divided, as in the removal of certain foreign bodies or papillomata in children (p. 622). (iii.) *Inter-crico-thyrotomy* or opening the crico-thyroid membrane, an operation to which the term laryngotomy has hitherto been applied (p. 624).

rapidly fatal dyspnœa. The question now lies between thyrotomy and tracheotomy. Both operations have serious disadvantages; in my opinion these are more marked in thyrotomy, and a further trial should be given to tracheotomy.

The disadvantages of thyrotomy are undoubted. It is very frequently insufficient, the growths quickly reappearing. It is liable, when repeated, to be followed by stenosis, this, perhaps, occurring in proportion to the vigour of the treatment. It is obvious that in little children—and these growths may occur in the first years of life—owing to the anæsthetic and the nature of the part which is operated on, there must be some risks at the time, and a little later. With regard to the aphonia which has been instanced against this operation, it is already present with the disease, and I know from one case in which the disease was eradicated by three operations, that the voice improves greatly with the growth of the child. While I consider tracheotomy to be preferable, I do not agree with such authorities as Dr. G. Hunter Mackenzie (*Brit. Med. Journ.*, vol. ii. 1901) "that a more unsatisfactory method of treating children, the subjects of these growths, could hardly be devised"; or with Dr. H. L. Lack (Watson Cheyne, C.B. and Burghard, *Man. Surg. Treat.*, pt. v. p. 438): "Thyrotomy must be entirely condemned. It is by no means free from danger, it may leave permanent impairment of the voice or stenosis of the larynx, and no patient should be exposed to such risks for a disease which can be far better treated by other methods." In my opinion, there is no really satisfactory treatment for these cases. But I consider that a surgeon would be justified in resorting to thyrotomy if he made use of eucaine and adrenalin to diminish the amount of general anæsthetic required, and if, by lessening the hæmorrhage, he gave himself the best possible chance of dealing with the growths. A solution of formalin should also be applied when the operation is completed.

When thyrotomy, tried with these recent advantages, has failed, it will deserve to be entirely abandoned.

The full description given at p. 660 of the technique of thyrotomy for malignant disease will suffice for those cases of papillomata or fibromata which occasionally occur in adults.

(ii.) Large rough foreign bodies*—*e.g.*, bits of bone, &c.

In a case brought before the Clinical Society (*Trans.*, vol. xvii. p. 214) by Dr. Taylor and Mr. Golding Bird a bit of mutton bone was impacted between the vocal cords, where it could be seen with the laryngoscope. It was removed by Mr. Golding Bird by a vertical incision with its centre over the cricoid cartilage, the crico-thyroid membrane being incised horizontally. A tracheal dilator being introduced, the bone was seen at once, and extracted with Toynbee's ear-forceps. The large size of the fragment, its apparently firm position, the fact that the broad surface, and not the edge, presented, together with its position just at the crico-thyroid membrane, led to the external operation being made use of.

Mr. M. Sheild (*Brit. Med. Journ.* 1902, vol. ii., p. 941) related a similar case successfully dealt with by thyrotomy. The bone had been impacted four days. Pus escaped when

* Mr. Holmes (*Med.-Chir. Trans.*, 1882) has drawn attention to the fact that large substances may be impacted in the ventricle or between the alæ of the thyroid cartilage without causing any symptoms of immediate urgency. As they are liable to give rise to spreading inflammation of the mucous membrane, they should be removed as soon as possible.

the preliminary tracheotomy was performed. The bone could not be seen when the thyroid cartilage was divided, but was detected very firmly impacted below the cords with the finger. The tracheotomy-tube was removed in twelve hours, and the wound then drawn together by sutures previously passed. The voice was, ultimately, completely recovered.

(iii.) Much rarer indications for thyrotomy are :—Cases of stenosis of the larynx as a result of injury or syphilis. Mr. Sheild gives two such cases. In that due to fracture of the larynx, thyrotomy a few months later with removal of the cicatricial tissue and dilatation of the larynx with the finger enabled the patient to dispense with her tracheotomy-tube, and to speak with a good voice at the time when she was last seen, two months after the thyrotomy. The syphilitic case admitted of less benefit, and retention of the tracheotomy-tube was needful.

Operation.—As a high tracheotomy will usually be required, it will facilitate matters, especially in little children, where the field is small, if the first incision is made from the top of the thyroid cartilage to a point about $1\frac{1}{2}$ inches below the cricoid. An ordinary tracheotomy-tube will suffice here if a small tampon of gauze secured with silk is placed above it. It affords an additional element of safety to open the trachea as a preliminary step, owing to causes of interference with respiration even in the case of a foreign body, as this may prove to be fixed ; as the upper part of the wound may usually be closed in these cases there is less need to make two distinct incisions, a step which may cramp the operator considerably. After the performance of the tracheotomy the next steps vary somewhat, according to the condition which calls for the operation. If it be a foreign body, the upper part of the incision should be deepened over the cricothyroid space, the membrane opened, and a tracheal dilator inserted. If the body be not seen, a probe will probably find it and suitable forceps extract it. This will prevent any of the interference with the vocal cords inflicted by a thyrotomy. If the latter step be required, as in the case of papillomata, after all hæmorrhage is arrested, the thyroid cartilage is divided along its centre with scrupulous exactness. This is easily effected in children with scissors introduced through an opening in the crico-thyroid membrane. The two halves, treated with the utmost delicacy, are now opened out with sharp hooks. A solution of eucaine and adrenalin (p. 652) is next applied ; and at this stage a trial of the Trendelenberg position may be made. In adults a fine pair of bone-shears or a very fine saw will be needed.

The removal of papillomata is often attended with much difficulty owing to their friability. They are best snipped away with small scissors curved on the flat ; as the application of fused chromic acid, silver nitrate, sulphuric acid, or the cautery have all failed in many cases to prevent the inveterate tendency to reappearance, a trial should be made of formalin. I have referred to the value of this in nasal polypi (p. 467) and in sarcomata (p. 451). Dr. Bronner, who drew the attention of the profession to the value of formalin in nasal polypi, has proved its efficiency in a case of laryngeal papillomata in an adult. After the fourth endo-laryngeal operation sprays of formalin (1 in 1000 up to 1 in 100, were employed, and for two years there had been no reappearance.

The object of the operation being accomplished, and all hæmorrhage arrested, the alæ of the thyroid are united by one or two points of silver suture not passed through the entire thickness of the cartilage. Iodoform and collodion are brushed over the wound and a boracic acid fomentation applied.

The tracheotomy-tube must not be removed till all risk of intra-laryngeal œdema, &c., has passed by, though it may be early replaced by one of india-rubber. The after-treatment and complications are much as after tracheotomy (pp. 634, 638). Coughing will be especially harmful now.

Impairment of the voice occurring after thyrotomy has been alluded to above. It may arise quite apart from any injury inflicted on the cords during the operation, owing to the cicatrix subsequently involving the anterior commissure of the cords. Other possible causes, in spite of aseptic precautions and gentle handling, are chronic laryngitis, the formation of granulations (p. 637), impaired movement of the thyroid, or displacement of the cords. Where the masses of papillomata are large, though the removal has been complete, the patient has in a few cases never been able to dispense with the tube. Before this course is decided upon, the presence of papillomata above the opening in the trachea must be thought of. In order to deal with them, the trachea must be opened again, a little lower down.

Treatment of Laryngeal Papillomata by Tracheotomy alone.

The results of thyrotomy for papillomata are so unfavourable both as regards reappearance,* much impairment of voice, and stenosis, and the endo-laryngeal operation and intubation are alike so ineffective, that it has been proposed to resort to tracheotomy alone with the object of giving entire rest to the parts: further, there is some reason to believe that, if unirritated, these growths have a tendency in early life to disappear. The disadvantage of this method is obvious, viz., the difficulties which will arise when the tube is ultimately dispensed with (p. 635).

Dr. G. Hunter Mackenzie was the first to bring this step forward (*Edin. Med. Journ.*, Nov. 1884; *Lancet*, April 6, 1889; and *Brit. Med. Journ.*, Sept. 12, 1896, p. 609), showing that the papillomata tended slowly to atrophy when the larynx was put at rest and freed from the irritation incidental to coughing, &c. The length of time during which the cannula† requires to be worn varies much. In Dr. G. H. Mackenzie's three cases it remained in the trachea twelve, six, and seven months respectively. Numerous confirmatory cases are given by this authority (*Brit. Med. Journ.*, vol. ii. 1901, p. 884). He agrees with the statement already made that the trachea should be opened as soon as the aphonia is complete and permanent, without any waiting for the onset of dyspnoea. To this Dr. Mackenzie adds the warning "that infraglottic papillomata may be present without much vocal alteration, but with considerable respiratory disturbance."

* In addition to this very marked tendency to reappearance there is the risk that the trachea may have to be opened to prevent suffocation after the child has appeared to be convalescent.

† An india-rubber tube is to be used whenever possible, and granulations springing up at the wound are to be destroyed at regular intervals.

Dr. Railton, of Manchester, published (*Brit. Med. Journ.*, Feb. 19, 1898, p. 489) two cases illustrating the value of this treatment. In one child the cannula was worn for three years and nine months, and in the other for twenty-five months, before it was finally removed*.

In these cases the condition of the voice and the breathing is examined from time to time by taking out the cannula and closing the opening, but the instrument is not finally withdrawn until every trace of stridor and hoarseness has disappeared.

George A. Wright, of Manchester, whose experience at the Pendlebury Children's Hospital has been very large, gives (*Ashby and Wright's Diseases of Children*, fourth ed. p. 350) an interesting case in proof of this warning.

In a child of 5, tracheotomy had been performed for laryngeal papillomata. The tube had been removed, at first for short intervals, and later altogether. The child died suddenly in an urgent attack of dyspnoea. The fact that, in addition to a mass of papillomata on the vocal cords and at the site of the tracheotomy wound, there was an early stage of tuberculosis of the bronchial glands and lungs, suggests, as is pointed out, the possibility of a hospital infection with tuberculosis through the tube.

The same authority is of opinion that "in papillomata of the larynx it is, on the whole, best to perform tracheotomy, leaving resort to thyrotomy for cases in which long use of the tube is unsuccessful."

LARYNGOTOMY OR INTER-CRICO-THYROTOMY.

In this operation the tube is inserted through an opening in the crico-thyroid membrane. It is called for, in preference to tracheotomy, on account of the greater facility with which it is performed, in cases of emergency, and in those where a tube can quickly be dispensed with.† Finally, it is inapplicable before adolescence.

Indications.

1. Sudden impaction of large foreign bodies threatening suffocation, as when a bolus of food carelessly swallowed lodges in the upper aperture of the larynx.‡

2. Before operations likely to be attended with much bleeding—*e.g.*, those on the tongue, jaws, tonsils, &c.—in order that the fauces may be plugged with a sponge. Of the value of this, proved in my experience, in many cases I have given repeated instances. Wherever the tube can be soon dispensed with, this operation is very superior to a high tracheotomy, often recommended.

3. When spasm of the larynx is threatening very suddenly, as in

* Possibly a cure may be secured in a shorter time by a combination of the methods; removing the papillomata carefully at once by a thyrotomy, and at the same time giving rest to the larynx by keeping a tube in the trachea. I will take this opportunity of adding one hint. As these papillomata are sometimes associated with congenital syphilis, it is always worth while to make a judicious trial of hyd. c. cret.

† Owing to the proximity of the tube to the cords, this operation is not suited to cases in which an instrument has to be worn for any time.

‡ In these very urgent cases the operation may be performed with, *faute de mieux*, a sharp penknife and a toothpick quill, or the opening may be kept patent for a time by retractors improvised out of bottle-wire.

tetanus or aortic aneurysm. As a rule, tracheotomy, when there is time to perform it, is preferred in these spasmodic affections, and it will be considered later (p. 647).

Operation.—An anæsthetic will be given in those cases in which laryngotomy precedes another operation; in other cases the patient's head must be kept steady. In either instance the head will be thrown back as far as possible, while the neck rests on a firm support. The precise position of the thyroid and cricoid cartilages is then distinctly made out, the notch in the upper part of the former and the ring of the latter being almost always recognisable. The larynx being then steadied (not squeezed) with the left fingers and thumb, and the skin at the same time drawn moderately tense, an incision about an inch and a half long is made, exactly in the middle line, over the lower part of the thyroid, the crico-thyroid interval, and the cricoid.

If relief be urgently called for, the knife should pass down to the crico-thyroid membrane at once, and the left index having identified this, the membrane is opened by cutting horizontally just above the cricoid cartilage. The object of this is to keep away from the neighbourhood of the vocal cords and to avoid the little crico-thyroid vessels.

If the surgeon have more leisure, he may reach the crico-thyroid membrane more gradually, feeling his way, using retractors, and perhaps identifying the interval between the sterno-hyoids. The only advantage of this is that all hæmorrhage can be arrested before opening the air-tube. This is sometimes severe, and has been fatal by dyspnœa.

In inserting the tube, care must be taken that both the crico-thyroid membrane and the subjacent mucous membrane are incised, and that the tube is really within the cavity of the larynx, not pushed down into the cellular tissue outside it. The space is always small, and, after middle life, increasingly rigid. The cannula, which should be shorter than those used for tracheotomy, of uniform bore throughout, and oval in section, is then secured with tapes.

TRACHEOTOMY (Figs. 247 and 248).

This operation will be carefully considered under the first of the following indications, and more briefly in its relation to the other ones.

Indications.

1. Croup and diphtheria.
2. Syphilitic and tubercular ulceration, in order to give rest to the crippled part (p. 646).
3. Malignant disease of the larynx (p. 674).
4. Papillomata of the larynx. By itself (p. 623) or as a part of the operation of thyrotomy (p. 622).
5. Acute laryngitis (p. 647).
6. Certain spasmodic affections, *e.g.*, tetanus, or aneurysm of the thoracic aorta (p. 647).
7. Foreign bodies in the air-passages: the removal of those which may lodge in the bronchi are treated separately (p. 652).

TRACHEOTOMY,* WITH ESPECIAL REFERENCE TO CASES OF MEMBRANOUS LARYNGITIS.

General points all bearing upon a successful result: †—(A) The age of the patient. (B) Right time of operating, and wise selection of cases. (C) Skilful operation. (D) Painsstaking and appropriate after-treatment.

A. **Age.**—Some of the youngest cases recorded (in pre-antitoxin days) are Mr. Bell's at seven months, and Mr. Cooper Forster's at eleven months.† The older children are, the more strength have they, and the better is the hope of recovery; whereas younger children fail more quickly, with their poorer vitality, and the greater facility with which their narrow air-passages are choked up with membrane, &c.

Average of Recoveries after Tracheotomy for Membranous Laryngitis.§—In pre-antitoxin days one case in three or four was a good average. Nowadays, especially in institutions where the rule holds good to inject 1000 or 1500 units of antitoxin serum in every case of laryngitis where there is a suspicion of diphtheria, and to inject it early in the course of the case, the percentage of recoveries has much increased owing to the effect the antitoxin has in loosening membrane and in preventing extension. One of the chief living authorities on diphtheria, Dr. E. W. Goodall, basing his calculations on a large body of statistics, is of opinion that, as a rule, in the pre-antitoxin days under 30 per cent. (perhaps 26 or 28 per cent.) of cases recovered after tracheotomy. At the present day the proportion of recoveries is about 63 per cent. (*Brit. Med. Journ.*, Jan. 28, 1899, p. 199).

B. Right Time for Operating,|| and Wise Selection of

* To speak accurately, the operation in children is often a laryngo-tracheotomy. The objections to this are given in a footnote, p. 630.

† If a little amplified, the conditions chiefly affecting success would run somewhat thus: 1. How far has the operator picked his cases? 2. What proportion were diphtheritic? 3. How many were very young? 4. Was the operation an early or a late one? 5. Was the operator experienced? Was the after-treatment skilled?

‡ M. Bazeau (*Gas. des Hôp.*, 1867, p. 397) mentions successful cases of tracheotomy in infants of ten and fifteen months. The very youngest cases with which I am acquainted are one in which Mr. Croft operated successfully in an infant aged six months, with erysipelatous œdema of the neck and chest, and another, still younger, which is quoted in the *Med. Times and Gaz.*, 1880, vol. ii. p. 593.

§ Turning to the results of foreign surgeons, Dr. Lindner (*Deut. Zeitsch. f. Chir.*, Bd. xvii. Heft 6) states that after the second year there was a marked improvement. In this year the recoveries amounted to 12 per cent., in the third year they rose to 55 per cent. Dr. Passavant, of Frankfort-on-Maine (*Annals of Surgery*, vol. i. p. 582) gives 67 cases of cure out of 229, or about 1 in 4.

|| Those surgeons who recommend an early operation (and I am of that number) rely especially on the existence of much sucking-in and of undoubted dyspnoea. With regard to the first, Dr. Passavant (*loc. supra cit.*, p. 153) holds that tracheotomy, if deferred, allows prolonged dyspnoea to bring about, simultaneously with retraction of the epigastrium, &c., an action on the lung surfaces analogous to that of a cupping-glass upon the skin—viz., hyperæmia, stasis, hypersecretion of mucus, splenisation, and atelectasis. With regard to dyspnoea, Dr. Ranke, of Munich, lays great stress upon an early operation: "If a child with pharyngeal diphtheria has become hoarse, and shows laryngeal stridor and difficulty in breathing, which has already led to ever so short an attack of real dyspnoea, that child ought to be operated upon at once." Another practical point

Cases.—The nature of the dyspnœa is very various, and on this account the above two points are most important.

The four following conditions of dyspnœa are met with: (i) Dyspnœa rapid, urgent, and localised to the larynx; much anxiety and restlessness; orthopnœa; stridor, the loudness of which is probably proportionate to the degree of obstruction in the larynx and the patency of the small tubes. In Prof. Buchanan's words, it points to a cavity ready to receive air if it could but get it, and to a passage narrowed either by false membrane or spasm, or both. On inspection of the chest, the extraordinary muscles of respiration are seen to be in action, there is much sucking-in of the infra-costal and epigastric, and, later on, of the supra-sternal and supra-clavicular regions. While this sucking-in is vigorous and well marked, the lungs are probably free. Auscultation and percussion are difficult. If the bases are resonant, and show vesicular murmur, it is of good omen. So, too, if the eyes, though starting, are bright, the face suffused, not livid, the lips of fairly natural colour, the cervical veins not much distended, the extremities not cold and the seat of stasis: in such cases the membrane, if present, is limited to the larynx, and the tendency to death is by laryngeal apnœa. Tracheotomy here is not only justifiable, but imperatively called for, if previous treatment has failed; the prognosis is favourable if the operation is not too long deferred. Hopeful conditions: Sudden onset, previous good health, absence of albuminuria, evidence of toxæmia little marked or absent.

(ii.) When the dyspnœa increases more slowly though continuously. The restlessness is less violent, and the respiratory effects are less exaggerated. The sucking-in is much less marked, especially above. The chest seems to be impeded in its movements, puffing or heaving out *en masse*, and with difficulty; on auscultation and percussion, instead of vesicular murmur, or conducted hoarse laryngeal rhonchus, and normal bases, there will be found sibilant râles, small crepitation, and deficient resonance. These point to the exudation being no longer localised to the larynx, but more probably invading the finer bronchial tubes and air-vesicles, the former being swollen and infiltrated with membrane, the latter clogged with viscid mucus. The tint of the face is now pale or leaden. The operation is here much less likely to be successful, from the extension of the membrane, and the condition of the lung and of the right heart. Other unfavourable conditions: Onset with much asthenia, albuminuria, evidence of toxæmia well-marked.

(iii. and iv.) Dyspnœa, intermittent or paroxysmal. In the former case it is due probably to collections of viscid mucus or membrane in the larynx and trachea. Good power of expectoration is here very important. Paroxysmal dyspnœa means spasm. This, very common in all laryngeal dyspnœa, is especially so in children. The danger of this is obvious, and the question of tracheotomy will have to be decided

bearing upon the right time for operation is the fact that at night-time children often get worse. If, then, a case is advancing, and parents cannot towards the day's close make up their minds to sanction an operation, they should be warned that the patient's condition may call for an operation which will be of necessity hurried, and performed under much less favourable circumstances as to light, &c.

according to whether the spasms are increasing, and by the distance of the medical man from his patient.

Dr. A. K. Gordon (*Med. Chron.*, 1902, p. 96) puts the indications for operation excellently. "They are in order of appearance: a croupy cough, laryngeal stridor, retraction of the epigastrium and inter-costal spaces, restlessness, cyanosis; then cessation of restlessness, cessation of retraction, followed by the apparent comfort which precedes death. It is important, however, not to take any one of them by itself, except apparent cessation of respiration, as an indication for operation; in the stage of active discomfort, where there is restlessness and dyspnoea, so long as there is no cyanosis, one should, nowadays, give a sufficient dose of antitoxin and wait, unless, of course, the case cannot be watched, in which case it may be best not to attempt to cure the patient without operation. It is when the stage of active discomfort is beginning to pass into that of diminishing distress—and this is invariably heralded by blueness of the lips—that the operation should be done. The sign of restlessness, however, deserves some mention, since its absence is occasionally taken as a sign that the operation is not required when the associated cyanosis should really demonstrate that the quietness is that of impending death, sometimes, too, its presence in a marked degree is the cause of an operation which is really premature, or unnecessary. It is well, too, to remember that retraction of the epigastrium during inspiration varies with the age of the patient. In a baby it is present in health when there is crying or struggling, and in small children a slight broncho-pneumonia will give rise to retraction when the larynx is healthy. In adults, and, occasionally, in big children, there is often no inspiratory retraction at all, though there be much laryngeal obstruction. The chief occasion in which tracheotomy is required in the absence of cyanosis is when repeated attacks of dyspnoea (especially after the first forty-eight hours of the disease) point to the presence of loose membrane in the trachea or larynx, in which case tracheotomy should be done in a quiet interval."

Three Chief Dangers of Deferring the Operation too long.

(1) Œdema of the lungs.* Owing to the deficient entrance of air, reflex contraction of the pulmonary arterioles takes place, leading to distension of the main trunk, the right heart, and systemic veins. The bronchial veins being also engorged, serous exudation takes place into the finer tubes and vesicles at the bases, and respiration is thus further impeded.

(2) Exhaustion of the heart. Children if they repair quickly are exhausted quickly also.†

(3) Thrombosis of the pulmonary artery. Owing to the stagnation in front, the blood current moves more and more slowly, and this obstruction by thrombi is not remediable by operation. The signs of this condition are increasing dyspnoea, very feeble pulse, and combined pallor and lividity.

Recommendation of the Operation to the Friends.—(a) In reply to

* See also the note, p. 626.

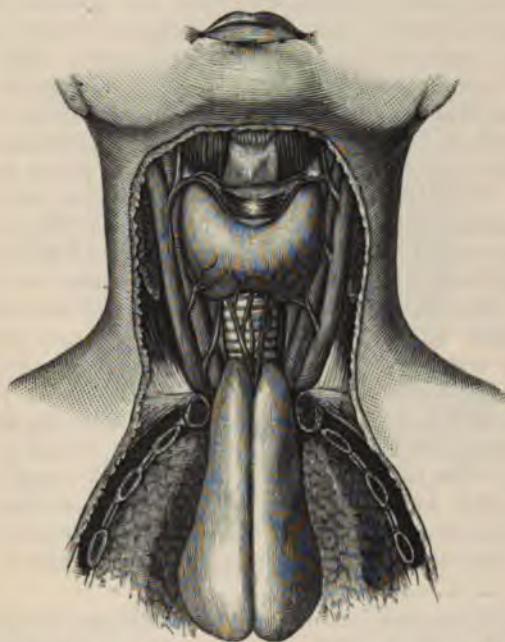
† Prof. Buchanan (*loc. supra cit.*, p. 208) makes an important distinction between sthenic and asthenic cases. In the latter, where the vital powers are rapidly failing, tracheotomy will not save the patient, and will scarcely, if at all, mitigate the suffering.

questions as to the chance of cure, the surgeon will answer, with caution, that the operation conduces to cure by removing the most urgent danger by giving relief to the lungs, and thus also improving the strength by sleep and quiet. (β) He will be able to say that if death occur after tracheotomy it will be by exhaustion, not by apnoea most distressing to witnesses as well as to the patient.

C. Points to be noted as to the Operation.

Question of Anæsthetic.—A little* chloroform is, as a rule, safe and advantageous. It allays spasm and thus improves the breathing. It prevents struggles and promotes sleep afterwards. Any vomiting which

FIG. 247.



Anatomy of the neck in early childhood, to show the relations of the thyroid† and thymus. (Heath.)

follows will probably be beneficial. It is especially useful in recent, vigorous, and restless cases; where the surgeon is very short of assistance, and where, if I may say so, his practical experience of the operation is not large. Under the opposite conditions it is not needed; and it will, of course, not be given where there is any tendency to cardiac failure or to cyanosis and unconsciousness. The greater the experience of the operator, the better his surroundings as to assistance, the greater the indication to dispense with chloroform. When an anæsthetic is given, the operator should be close at hand, with everything ready, in case the dyspnœa increases suddenly. The question of the use of

* Just enough to prevent struggling during the operation. After the skin is incised, less is needed.

† The isthmus of the thyroid gland is too large.

eucaime, with or without chloroform, is referred to at p. 650; it is obviously more adapted to adults.

Site of Operation.—High or low,* *i.e.*, above or below the isthmus. It will be worth while just to consider here the parts met with in the middle line, (A) above and (B) below the thyroid isthmus. (A) Skin, superficial fascia, branches of transverse cervical and infra-mandibular (seventh) nerves, lymphatics, cutaneous arteries, anterior jugular veins—which with their transverse branches are smaller here—deep fascia, cellular tissue, superior thyroid vessels, the isthmus, usually over the second and third rings,† and tracheal layer of deep fascia. The importance of this last is twofold: if the trachea be insufficiently opened the tube may be passed between the trachea and the fascia overlying it, embarrassing the patient's breathing and the operator alike. If the wound become unhealthy, this layer, continuous below with the pericardium, may conduct pus into the mediastina. (B) The surface-structures are much the same, but the anterior jugular vein and its transverse branches are much larger. The sterno-thyroids are here‡ quite close together. The inferior thyroid veins are larger. A thyroidea ima may be present, and the innominate artery cross as high as the seventh ring. The trachea is also deeper, smaller, and more mobile, having no steadying muscles here as higher up. The thymus, too, in young children might present a difficulty. In addition to the above anatomical objections to the low operation, there are three surgical ones, *viz.*: (1) Pus is now more easily conducted into the mediastina. (2) In the same way, broncho-pneumonia is more probable from a wound in the trachea lower down. (3) From the proximity of the chest, and its suction-action, the tube is much more pulled into the wound, and, if it has to be worn for a long time, the tube and shield may part company (Mr. J. Wood, *Lancet*, 1872, vol. i. p. 317).

Operation.—The instruments required are—a small scalpel, with a triangular-pointed handle to act as a blunt dissector, two pairs of Spencer Wells's forceps, dissecting-forceps, steel director, silk or chromic gut ligatures, one or two wire sutures, pilot, and tube.§ They should

* In children the operation done is a laryngo-tracheotomy, the parts usually divided being the upper two or three tracheal rings, the isthmus of the thyroid, and the cricoid cartilage. But the last is not to be divided if possible; the higher up the tube is inserted, the greater the irritation it causes.

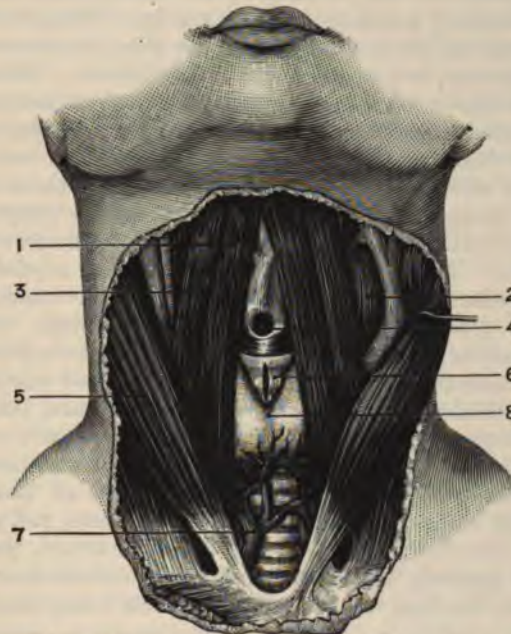
† Mr. Parker (*Tracheotomy*, p. 37) says that in children the isthmus is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring.

‡ Above, the sterno-hyoids are almost in contact in the middle line, with only an interval of about one-eighth of an inch—a strong argument in favour of keeping in the middle line exactly (Parker).

§ The best tracheotomy-tubes are those of Mr. Durham, Mr. Bryant, and Mr. Parker. If the first are chosen, they must be of reliable manufacture. The ball-and-socket of Mr. Bryant's tubes allows of free play. Whatever tube is chosen, it should have a movable shield to prevent irritation of the trachea, and it should just fit snugly in the trachea, being lightly held by this. Mr. Parker (*loc. supra cit.*, p. 84) argues strongly in favour of angular tubes. He shows that the usual quarter-inch tubes impinge with their lower extremity on the anterior wall of the trachea, thus tending to produce ulceration and grave risks (p. 638). Mr. Parker, from my experience, entirely proves his point. Whatever tube is chosen, it should be as large and as short as possible; it should be of the same size throughout, without tapering; the inner tube should project a little beyond the outer one; while the whole tube should fit snugly, standing out as little as possible in the neck.

be spread out ready to hand, as, in an instant, moving the child or beginning the anæsthetic may cause most urgent dyspnœa. The question of the anæsthetic has already been alluded to (p. 629). The child's neck and head, at first raised and relaxed,* are stretched over a sandbag or a large bottle wrapped up in a towel, while the hands are secured in the jack-towel which firmly encircles the body. Three assistants at least are required—one to support the head and give the anæsthetic, another to sponge, and the third to prevent any struggling and to hold a light if needed. It is almost superfluous to add that the light should

FIG. 248.



Anatomy of the neck in an adult: 1, Sterno-hyoid. 2, Foreign body in the œsophagus. 3, Omo-hyoid. 4, Crico-thyroid membrane. 5, Sterno-mastoid. 6, Tracheotomy opening in the trachea. 7, Inferior thyroid veins. 8, Isthmus of the thyroid gland. (Heath.)

be the best possible; an electric light may be of much use in illuminating the bottom of the wound. The surgeon† with his left thumb and

As to the size of the tubes needful, Mr. Parker recommends a series running from No. 18 to No. 30, French gauge, the most useful sizes for children being Nos. 18, 20, 22, 24, 26, and 28 for the outside tube. Of these sizes the following are the most useful: No. 24 in children from one to three, and No. 26 in those from three to seven. On this matter of the size of the tube and its relation to the aperture of the glottis and size of the air-tube, the reader should consult Mr. Holmes (*Dis. of Children*, p. 324), Sir. H. Howse (*Guy's Hosp. Rep.*, 1875, p. 495), and Mr. Marsh (*St. Barthol. Hosp. Rep.*, vol. iii.).

* Whenever an anæsthetic is being given in cases of dyspnœa, the patients, whatever the age, should be allowed to choose their own position at first, and any movements or alterations in the position of the head and neck, preparatory to the commencement of the operation, should be carefully made.

† He first, as soon as the head and neck are in position, marks the chief spots in the

forefinger steadies the trachea, and makes it a little prominent as well, without any compression; he then incises the soft parts in the middle line from about the centre of the cricoid* downwards for about two inches, cutting well through the fat, often abundant here, and exposing the interval between the sterno-hyoids; he incises this interval, and, if he has reason to fear hæmorrhage, with the point of a steel director placed in the upper part of the wound, he slits down the remaining soft parts in the middle line till he can distinctly feel or, with the aid of retractors, see the tracheal rings.† The point of the knife is often required here to incise surely the tracheal fascia. Until the tube is distinctly exposed the left forefinger and thumb must not be removed from their steadying position on either side. With the blade of the knife held upwards, the middle line of the front of the trachea is then punctured, stabwise, and two or three rings divided. The sufficiency of the opening is known by a free and noisy rush of air, accompanied often by the expulsion of membrane, which should be sponged away at once. On the other hand, an inadequate opening will be indicated by the hissing only of air through the slit-like opening, without any free rush and with no escape of membrane or relief of the dyspnœa. In this latter case the first opening must be found by the finger-nail and carefully enlarged.‡ The cannula is then inserted on a pilot, and secured with tapes *in situ*. Some prefer to use a hook to steady the trachea, and a pair of dressing-forceps to dilate the opening; these are more likely to be helpful in a "low" operation, or where a pilot is not used to insert the cannula. If it be desired to try and remove any membrane,§ the cannula should not be inserted at once, but the opening dilated with dressing-forceps, or with Mr. Golding Bird's or Mr. Parker's dilator. When inserted, the cannula must lie in the middle line, otherwise there will be troublesome irritation of the trachea and plugging of the cannula. I have spoken (footnote, p. 631) of the size of the tube. The larger the tube that can be inserted, the more snugly it rides in the trachea, the less the irritation and consequent formation of granulations, the less the risk of membrane being drawn down past

middle line—viz., centre of the chin and manubrium, and (when they can be felt) the hyoid bone and the thyroid and cricoid cartilages, especially the last.

* This cartilage is often incised—a point to be, however, avoided. The parts are so small in a child that a tube put in by incising the cricoid is likely to irritate the larynx. Of this the cricoid is the narrowest and a very rigid part. Only the smallest cannulae can be used here.

† Dr. Buchanan considers the following a golden rule: "Never plunge the knife into the trachea till the white rings are clearly seen in the bottom of the wound." In cases of real urgency the surgeon must be satisfied with touch and not with sight.

‡ If the opening be to one side, as well as too small, a fresh and adequate one should be made in the middle line.

§ Mr. Parker, one of the chief authorities on this subject, strongly advises that all membrane as well as mucus be got rid of, on account of its impediment to respiration, its infectiousness, and the patient's inability to get rid of it himself by coughing after tracheotomy. On this account Mr. Parker recommends gently twirling about a feather (the shorter and finer pheasant-tail feathers are the best) soaked in a solution of sodium carbonate, and passed several times, not only down into the trachea, but up into the glottis. Mr. Parker condemns attempts to suck out membrane by putting the lips directly to the wound, as of no service to the patient, and as possibly very disastrous to the operator. The aspirator he recommends is alluded at p. 634.

it from above, and lastly, the less frequently will it need changing. The wound should be sutured, around the tube closely, with salmon gut or silver wire.

Chief Difficulties.—(1) Insufficient skin-incision, giving no room for the deeper work.* (2) Not keeping to the middle line; the abundant fat, and the indistinctness of landmarks—*e.g.*, a flat thyroid in a little child—aiding this mistake. (3) Not steadying the trachea. This omission leads to missing the tube altogether. Cutting to one side of it, or cutting into it laterally, instead of centrally, and insufficiently. (4) Hæmorrhage, the chief bugbear of the operation, varies extremely. Generally it is not great. The greater the experience of the operator, the more strictly he keeps in the middle line, the more rapidly he is able to operate safely, the more may the bleeding be disregarded. Any artery which springs should of course be tied at once or caught in Spencer-Wells's forceps, and a vein of any size which lies in the way should be caught between two of these forceps before it is divided. Venous hæmorrhage, as a rule, stops as soon as the trachea is opened and respiration established. A sufficient median skin-incision aids the meeting of hæmorrhage. With regard to the isthmus of the thyroid, this may usually be neglected by the surgeon; if felt by the finger to be large, it may be depressed.† If encountered in older subjects, or if large in children, it may be compressed by two pairs of Spencer-Wells's forceps before division, or ligatured on either side by passing an aneurysm-needle beneath it. If, as rarely happens, the venous bleeding is very free, and the patient's condition from dyspnœa critical, the trachea must be felt for and opened before the hæmorrhage is arrested. The urgency of the case must here come before the amount of the bleeding. In these cases the moment the tube is opened the patient must be turned well over on to his side. Entrance of blood, to any amount, into the lungs must be avoided; it will add to the dyspnœa now, and, later on, may set up broncho-pneumonia. (5) Insertion of cannula. If the trachea has not been steadied, and the rings not clearly made out by sight or touch, the opening will very likely be made inadequate or to one side. Another difficulty may arise here from the tracheal fascia not having been sufficiently cut, or from the tube being pushed down between this fascia and the trachea, this, of course, only further embarrassing the breathing. Lastly, though the tracheal rings are cut, the swollen and inflamed mucous membrane may not have been sufficiently divided, or a false membrane may have, in the same way, been carried before the knife. (6) Little or no relief after insertion of the cannula. Though this may have been well and truly done, it is not followed by the relief which has been expected. This may be due (*a*) to the tube being passed between the trachea and some membrane which plugs it; (*b*) to the trachea and bronchi being blocked with membrane, &c.; (*c*) to the child, owing to the operation being performed late, being practically asphyxiated before the completion of the operation. The indications now are to pass a long narrow

* As in a colotomy, or any other deep incision, the wound should not be funnel-shaped.

† In children this may certainly be ignored. If the knife is used to open cleanly and sufficiently the deep fascia, and then a round-pointed steel director to clear the way down to the trachea, the operation will be almost bloodless.

feather down the tube, to remove the tube, and to clear out the trachea, while artificial respiration is vigorously performed and kept up, the opening into the trachea being kept patent by dressing-forceps or by one of the dilators above mentioned (p. 632). If feathers or brushes fail to reach and remove the membrane, trial may be made of aspiration. The best means of effecting this is by Mr. Parker's tracheal aspirator, which consists of a small glass cylinder, three or four inches long, to one extremity of which the end of a silk catheter is attached, and to the other an india-rubber tube ending in a mouthpiece (*loc. supra cit.*, Fig. 12, p. 98). It can be taken to pieces to facilitate cleaning. Before use a little cotton-wool is packed into the cylinder to prevent any dangerous membrane reaching the operator's mouth. Direct suction should never be performed in membranous laryngitis; in other cases where blood alone is the cause of the dyspnoea, it may of course be thus removed.

D. After-treatment.

This subject, neglected in most books, is often too little looked to in practice. The question of the most suitable atmosphere for the patient will first arise. By most a tent (readily improvised by converting a cot into a four-poster, by fastening on four vertical pieces of wood at the corners, joining these by four horizontal pieces, and throwing a sheet over all) is recommended, and, one side of the cot being left uncovered, steam is conducted thither by one of the different forms of croup-kettles. While fully aware of the need of moisture when the atmosphere is dry, when the membrane tends to crust and become fixed, I am of opinion that the above unvarying rule of cot-tenting and use of steam is disadvantageous. The weakly condition of children with membranous laryngitis, and all that they have gone through, must be remembered. Believing that such seclusion and so little admission of air tend to increase the asthenia, and any tendency to infection, I much prefer to be content to keep off draughts by a screen, which allows of the escape of vitiated air above, using steam only if needful, according to the size of the room, fireplace, &c., and according to the kind of expectoration,* whether easily brought up by cough or feathers, or viscid, quickly drying, and causing whistling breathing. If the temperature can be otherwise kept up to 60° or 65°, I much prefer to use a warm boracic acid fomentation. The inner tube must be frequently removed and cleansed, every hour or two at first. If the secretions dry on and cling to it, they are best removed by the soda solution mentioned below. At varying intervals between the removals of the tube, any membrane, &c., which is blocking it, appearing for a moment at its mouth and then sucked back, must be got rid of by inserting narrow pheasant feathers, and twisting them round before removing them. If the exudation is slight, moist, and easily brought up by a cough or

* G. A. Wright (*Dis. of Child.*, p. 164) quotes from Cocks (*Arch. Pædiat.*, Jan. 1884) that sudden obstruction of the tube is most often due to inspissated mucus, not membrane; this thick mucus is secreted usually about twenty-four hours after the operation, and after three or four days the discharge becomes thinner and more puriform. But blocking of the tube with membrane does certainly occur; it is known by the sudden cyanosis and struggles of the child, while no air enters the tube. The whole tube must be removed; if this and the consequent coughing does not expel the membrane, the wound must be dilated, and the membrane extracted.

feather, sponging and brushing out the trachea are not called for, but they should be made use of when there is much flapping, clicking, or whistling of the breathing; and if this is harsh, dry, or noisy, instead of moist and noiseless, two of the best solutions are sodæ bicarb. gr. v.-xx. to aq. 3j., or a saturated one of borax with soda. These may be applied by a hand or steam-spray over the cannula for five or ten minutes at a time, at intervals varying according to the relief which is given, or applied with a laryngeal brush, feather, or a bit of sponge twisted securely into a loop of wire. When any of these are used, the risk of excoriation and bleeding, and the fact that only the trachea and large bronchi can be cleaned, must be borne in mind; and with regard to manipulations for cleansing the trachea, and removing the inner tube, it is most important to remember that the caretaking may be overdone, and a weakly child still further exhausted by meddlesome interference. This point requires special attention from the surgeon in the case of some of the nurses of the present day, who seem to wish to transfer the entire charge of the patient into their own hands.

There is often much difficulty in getting sufficient food taken. This, and the amount of sleep are two most important points. For the first twenty-four hours the child should be disturbed as little as possible. The pain in swallowing, the impairment of the act owing to the presence of the tube, &c., and thus the facility with which liquids may reach the lungs, are facts to be duly remembered. It will usually be better to pass a Jaques' catheter (No. 4 or 6) by the nose, and then to feed the patient, at regular intervals, with definite amounts. Care must be taken to see, by the absence of irritation, that the tube is not in the larynx, and, if the above soft tubes are used, that they do not coil up at the back of the tongue.

The removal of the tube next requires consideration. It should be dispensed with at the earliest possible opportunity, either altogether, or replaced by an india-rubber tube between the fourth and ninth days. Quite apart from the danger, which is inseparable from a metallic tube,* of irritation and ulceration of the trachea, there is this object in getting rid of the tube as soon as possible, that the longer the child is allowed to breathe through the tube the more is the act of breathing through the natural passages allowed to be, as it were, forgotten, with the result that, on the tube being removed, asphyxia is threatened. The chief point to go by in deciding as to whether the tube can be safely dispensed with or replaced by one of india-rubber is the freedom of entry of air through the larynx, and absence of any sucking in below, and whether some skilled observer can remain present and decide whether sufficient air is reaching the lungs through the larynx and through the wound without being in a nervous hurry to replace the tube.

Conditions which Impede the Removal of the Tube.—(1) Prolonged formation of membrane. The longest possible period for this is probably about ten days. Patience and support are the main indications in the treatment here. (2) The larynx is crippled like any other

* Mr. Parker points out (*loc. supra cit.*) that black patches seen on the outer tube when removed may indicate ulceration of the trachea, and show the need of changing the tube. In my experience, such discoloration may point, here and in intubation, to an inferior quality of the metal of the tube.

inflamed part. (3) The air tube is closed by granulations, usually above the cannula. More common than these is obstinate swelling of the mucous membrane. Here some advise that the tube be removed, and astringents and caustics carefully applied from below, with the aid of an anæsthetic if necessary. My own opinion is that it is often wiser to reinsert a tube of large size, with a hole on its convexity, and to leave it in for a week or two, thus giving further rest to the parts. Needless resort to caustics will certainly risk the occurrence of stenosis, later on. (4) Closure of larynx by deep ulceration cicatrising after detachment of membrane. In such a case, with the aid of anæsthetics, the larynx must be opened up by probes of increasing size and laminaria tents introduced from below, and later on by the use of Macewen's tubes (p. 637). (5) Paralysis of the dilating crico-arytenoidei postici, or spasmodic action of the closing ones, arytenoidei or crico-arytenoidei laterales, from fear, excitement, or during effort.* (6) The commonest cause of inability to dispense with the tube is probably due to the rapidity with which the larynx falls into abeyance when a child is allowed to breathe through a tracheal cannula, the patient at this age being not intelligent enough to understand the importance of dispensing with the tube, and perhaps too young to care to talk, or, if older, not realising the need of again using its voice while all its wants are supplied. With the above condition are coupled a nervous dread of having the tube removed, and paroxysms of temper and struggling which rapidly produce embarrassed breathing. Any organic mischief, such as adhesions in the larynx, is I think, extremely rare, and granulations above or below the tube are more often talked of and given as a reason for inability to dispense with the tube than really seen.

But while real organic mischief is rare and the usual cause is due to conditions which would seem to be only temporary, it is well known that, in some cases, getting a little child to dispense with the tube is a most baffling and prolonged affair. The following points are worthy of attention:—Early attempts to remove the cannula, whether metal or india-rubber. A reliable nurse. Ability on the part of the surgeon so to arrange his time as to be himself frequently present at first, and, in the intervals, to be represented by an assistant who will not replace the tube before it is absolutely necessary to do so, and who can dilate the opening with a pair of dressing-forceps and perform artificial respiration if these steps are required. Shortening the india-rubber tube, till eventually little more than the shield is worn, the child being comforted by the apparent presence of the tube. Encouraging the child to make use of his larynx by breathing through the tube and expiring through the larynx while the tube is closed. Patiently persevering efforts to get a child to talk, or, in the case of a younger one, to use his larynx by blowing out a spirit-lamp or using a penny trumpet.†

* In a case in which I had performed tracheotomy, and was watching the child for the first few hours after the tube had been dispensed with, most urgent symptoms came on during the slight straining which accompanied an action of the bowels, the patient falling off the bed-pan on to the floor apparently lifeless. Artificial respiration restored the child, and the case did well.

† I may advise my readers to consult a most practical paper by Dr. Steavenson (*St. Barth. Hosp. Rep.*, 1881).

All this time every attempt should be made to improve the general health: wise feeding (too frequent or too large meals provoke dyspnoea), attention to the bowels, such tonics as Easton's syrup, proper clothing, cold or tepid sponging followed by friction, change of scene and air in every possible way, especially at the seaside.

In a large majority of cases the above treatment, aided by patience, tact, and time, which allows of development of the air passages, will suffice. In a few the attempts at removing the tube will still fail. Where this is so, and, in fact, in any case where the use of the tube seems likely to be protracted, the larynx should be dilated—a step which is brought about by simple means, as the larynx is usually merely functionless from disuse, not blocked up, or the glottis closed—by a tube through which the child is made to breathe.

In a recent case the simplest way of effecting this is, after chloroform has been given, to remove the tracheotomy-tube, dilate the wound if needful, and pass upwards from it a drainage-tube or catheter with a double silk web; the upper end of this is drawn out of the mouth (with the aid of a gag if needful), and tied to the lower end which projects through the wound. The tracheotomy-tube is then replaced for a day or two, and on the withdrawal of the tube from the larynx it can usually be dispensed with altogether. Another very simple and efficient means is thus given by G. A. Wright (*loc. supra cit.*, p. 165): "A flexible probe should be passed up through the glottis from below, and a piece of silk carrying a small sponge be attached to it; the probe should then be drawn out through the mouth, and the sponge carried through the larynx sweeps it out, breaks down any adhesions, and clears away mucus or any granulations."

Occasionally, in cases of longer standing, the above simple treatment may not be sufficient, and here intubation with vulcanite tubes (pp. 645 and 646), or the use of Macewen's tubes passed through the larynx* and into the trachea below the wound should be made use of. If intubation tubes are not available, chloroform having been given, one of Macewen's tubes—they resemble stout gum-elastic catheters with terminal carefully-bevelled openings—is passed from the tracheal opening† up through the larynx into the mouth. Having hooked this end out of the mouth,‡ the surgeon now passes the other end down the trachea beyond the wound, a step sometimes accompanied with difficulty. The object of the surgeon should be to place this lower end of the tube only just below the tracheal opening, so that air is drawn in from the end projecting through the mouth into the trachea, without leaving any needless length of the tube here or in one bronchus for fear of setting up irritation or secretion. To prevent the child pulling out the tube, the hands should be secured for the first few hours, and to prevent the tube being bitten it is well to pass a piece of drainage-tube§ over the first few inches. This end is then secured

* See a paper by Mr. Bilton Pollard (*Lancet*, 1887) on this subject.

† It is more easy to pass the tube this way owing to the facility with which, when passed from above, it finds its way into the oesophagus.

‡ The tube will be found to pass readily behind the soft palate.

§ This simple means is much better borne by the child than the gag. I owe its suggestion, some years ago, to Dr. Arthur E. Poolman.

with tapes around the head. The tube may be left in from twelve to eighteen hours, according to the amount of secretion and the facility with which the tube is blocked. While this treatment is being carried out it is well to isolate the child in a separate room, as the breathing through the tube is very noisy, being often accompanied by very loud bubbling sounds, and the aspect of the child while this necessary dilating of the larynx is going on is one of apparently great distress. When it is evident that the tube is clogged it must be withdrawn and cleansed, and, a little anæsthetic having been given, again inserted. At any time, if needed, the cannula must be re-inserted and artificial respiration performed. It will readily be understood that during this time the presence of the surgeon, and reliable assistants who will not lose their heads, and nurses with much tact and temper, are pre-eminently required. Even when laryngeal breathing is restored and the tube has been dispensed with, the child must be carefully watched, especially at night. If natural breathing fails, it is better, whenever there is time, to replace the Macewen's tube in the trachea rather than re-insert the tracheotomy-tube into the old wound, a mode of relief which is too likely to be resorted to on account of its facility, but one which tends to keep up the sinus-like nature of the wound in the trachea, and brings back that most pernicious tendency of the child to prefer and confide in this mode of breathing.

Complications of the After-treatment.

(a) *Hæmorrhage*.—This is not common; if immediate, it is due to some vessel having been left unsecured. Later on, it may be brought about by ulceration of the trachea set up by the pressure of the cannula;* through separation of the false membrane by sloughing; a velvety and swollen condition of the mucous membrane; or by prominent granulations. The treatment is clearly preventive—to dispense with a tube, especially a metal one, as soon as possible, and from the first to use one of appropriate length and curve (footnote, p. 630).

(b) *A Sloughy Condition of the Wound*.—If this is threatening, attention must be paid to the tightness of the tapes, so that the cannula be not needlessly buried in the wound, and to the wearing of a collar of boric lint under the shield. The tube must be removed at intervals, or replaced by an india-rubber one, air tending to enter without a tube as soon as the edges of the wound are set and healing. If the wound be not only sloughy, but gangrenous and diphtheritic, in addition to frequent cleansing with a camel's-hair brush, the use of iodoform and hot boracic or zinc chloride lotions, stronger measures, such as the application of pure nitric or carbolic acid, will be called for. The general treatment will not, of course, be neglected in these cases.

(c) *Emphysema*.†—This is usually the result of a faulty operation.

* Some undoubted cases of ulceration into the innominate after low tracheotomies in children are on record—*e.g.*, *Path. Soc. Trans.*, vol. xi. p. 20.

† On this subject the reader should consult the full and detailed papers of Dr. Champneys, in vols. lxx., lxxvii., and lxxviii. of the *Med. Chir. Trans.*, and his work on *Artificial Respiration*. The following are amongst the practical conclusions with which his pages abound: (1) Emphysema of the anterior mediastinum, often associated with

The incision into the trachea is either wrongly placed—i.e., it is not in the same line with that in the soft parts—or it is too small; perhaps two small ones have been made; very rarely is the emphysema due to too large an incision in the trachea. Or, the incision may have been correctly made, but some fault connected with the tube may produce the emphysema; thus it may have been originally too short, or have been pushed out of the wound by swelling of the soft parts or by coughing. As a rule this complication is not dangerous unless it be extreme in very young children, or unless it travel deeply; under these circumstances scarification must be made use of, if possible.

(d) *Ulceration of the Trachea.*—This is usually due to the pressure of a cannula faulty in length or curve, much more rarely to separation of membrane or sloughs. There are no definitely characteristic signs of this complication; the following point to it: Streaks of blood expectorated a day or two after the operation, and perhaps discolouration of the lower end of the tube. This accident is especially likely to occur in cases of diphtheria, where antitoxin has not been given or delayed, as the vitality of the tissues is here much lowered. The tube should be left out if possible, or an india-rubber one substituted, worn as short as possible, and cut obliquely so that the end does not impinge upon the anterior wall of the trachea. If it is necessary to dispense with all tubes, attempts may be made to keep the edges of the tracheal wound stitched to that in the soft parts for a few hours, or Mr. Golding Bird's dilator may be worn.

(e) *Suppuration in Mediastina.*—This is a rare complication. When it does occur it is liable to be very rapid. It results from a descending cellulitis from the wound. The only treatment is prevention by a well-performed operation, and by attention to the wound.

Other complications which are not surgical may, of course, be present—viz., Extension of the exudation downwards. General infection. Paralysis. Albuminuria. Broncho-pneumonia—a very frequent one, known by a rise of temperature with frequent respiration and dyspnœa, dulness on percussion, bronchial breathing, with bubbling and crepitant râles. The discharge becomes scanty, the child is restless with a tendency to lividity, and there is a return of the sucking-in in the supra-clavicular and epigastric regions, while no obstruction is found in the tube. The antitoxin treatment has very largely lessened the frequency of the above mentioned difficulties and complications of the after-treatment.

pneumothorax, occurs in a certain number of tracheotomies. (2) The conditions favouring this are, division of the deep cervical fascia, obstruction to the air-passages, and inspiratory efforts. (3) The incision in the deep cervical fascia downwards should not be longer than needful; it should on no account be raised from the trachea, especially during inspiratory efforts. (4) The frequency of emphysema probably depends much on the skill of the operator, especially in inserting the tube. (5) The dangerous period during tracheotomy is the interval between the division of the deep cervical fascia and the efficient introduction of the tube. (6) If artificial respiration is necessary, the tissues should be kept in apposition with the trachea, and any manipulations performed without jerks.

INTUBATION OF THE LARYNX AS A SUBSTITUTE FOR TRACHEOTOMY IN MEMBRANOUS LARYNGITIS OR STENOSIS OF THE LARYNX.

Attention was first called to this subject by Sir W. Macewen (*Brit. Med. Journ.*, July 24 and 31, 1880). The tubes he used have been alluded to at p. 637. It was, later on, more prominently brought forward in America.*

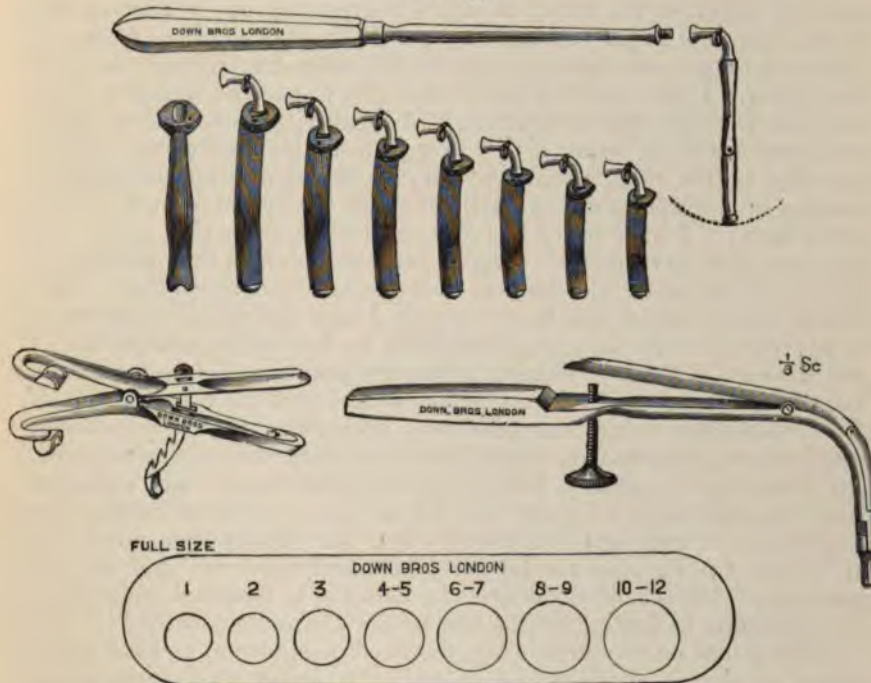
The **Advantages** claimed.—The chief of these, the easy and rapid introduction of a tube, has been substantiated of recent years, when the favourable conditions of special skill and experience are granted. On the presence of these conditions the whole question turns (p. 644).

(1) The consent of the friends will be more quickly obtained than in the case of tracheotomy. (2) Intubation requires no anæsthetic. (3) The tubes are easily and quickly introduced, and thus the operation is much more rapidly performed. (4) There is no severe or difficult operation as in tracheotomy. (5) The inspired air is drawn warm and moist through the natural passages; thus the depressing effects of a steam-tent are avoided (Codd, *loc. infra cit.*). (6) There is no open wound requiring careful treatment, and there is not the same difficulty in getting rid of the tube. (7) The after-treatment is therefore much less prolonged. This advantage is not to be expected invariably. In the words of Dr. F. Wright, of New Haven, U.S.A. (*Pediatrics*, Feb. 15, 1899): "It occasionally happens that after the original trouble for which intubation was done has disappeared, it is impossible to remove the tube from the larynx without dyspnoea returning, necessitating the return of the tube. Such a condition is termed 'retained tube.' O'Dwyer, the authority upon all matters pertaining to intubation, in a paper read before the American Pediatric Association in May 1897, said that 'the cause of persistent stenosis following intubation in laryngeal diphtheria can be summed up in a single word—"traumatism." Paralysis of the vocal cords may possibly furnish an occasional exception to this rule.' The reason of the traumatism may be a tube that does not fit, one that is imperfect in its construction, or injury to the tissues by unskilled operators. Undoubtedly most of the cases of retained tube are due to the tube being too large, notwithstanding the size designed for the age has been used. This condition has most frequently happened when the 3 to 4 size has been used. If the pressure is great enough to seriously interfere with the circulation, even if it does not cause ulcer, there will be an œdema of the surrounding tissues. The tube being withdrawn, the pressure is suddenly removed, and the submucous tissue becomes infiltrated, and, being surrounded with cartilage, can swell in but one

* Especially by the late Dr. O'Dwyer, whose first paper appeared in the *New York Med. Journ.*, Aug. 1885. Amongst many other more recent papers are—O'Dwyer, *Arch. of Pediat.*, 1897, xiv. p. 481; those by Dr. F. Wright, of New Haven; Dr. Lovett, of Boston; Dr. Codd and Dr. E. W. Goodall, of this country (*Edin. Med. Journ.*, vol. i. 1902, p. 223). The last mentioned writer is an authority not only on intubation, but also on those diseases which may call for it. A paper by Dr. Basan (*Lancet*, July 13, 1901, p. 76), who was trained by Dr. Goodall, will also be found helpful with its cases and practical details.

direction, thus obstructing respiration by narrowing the lumen of the larynx. Sometimes the head of the tube, by making undue pressure upon the parts on which it rests, causes an abrasion from which granulations spring, and, as the tube is removed, these drop down into the chink of the glottis and obstruct respiration." Dr. Goodall, who only met with ulceration of the larynx four times in 101 cases of intubation, concludes as follows:—"Be very careful in the introduction of the

FIG. 249.



Dr. Codd's set of intubation instruments for children, consisting of seven of O'Dwyer's model vulcanite intubation tubes, fitted with Codd's obturators, introducer, and extractor; Denhard's gag, self-retaining; and gauge-plate. Here there are seven obturators, but only one handle to the shaft. In the newest O'Dwyer's model there is a separate shaft to each obturator, all fitting one handle (Down Brothers' Catalogue). Dr. Goodall prefers Bayeux's modification of O'Dwyer's instruments made by Collin, of Paris, the tubes being shorter and lighter, and the method of attaching the obturator to the introducer better.

tube. Do not intubate when the larynx is much swollen. If in any case intubation is found to be difficult, do not persist too much in your efforts, especially if your experience of the operation is limited. Lastly, do not intubate the same case more than three times. If these rules are adhered to, I believe that ulceration of the larynx will occur no more frequently after intubation than it does after tracheotomy."* (β) Intubation may fail, and its failure on any

* Bokay (*Deut. Med. Woch.*, 1901, No. 47) reports five cases in which removal of the intubation tube at the end of periods varying from 107 to 294 hours led to alarming
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of the following grounds may necessitate tracheotomy (Goodall). (1) Intubation may not relieve. (2) Some time after removal of the tube dyspnœa may recur, and the patient's condition be too serious to allow of re-intubation. (3) The tube may become suddenly blocked (*vide infra*). (4) Failure may follow an attempt at re-intubation. (5) The medical man called to the patient may have had no experience of intubation. (6) The larynx may be ulcerated.

Disadvantages, Difficulties, and Dangers.—(1) In Dr. Codd's words, "The epiglottis may be very turgid, and the parts generally œdematous, and the point of the tube, though entering the upper part of the larynx, may fail to get through the glottis or even to get as far as it. This can be got over by thrusting the left index-finger firmly down to the glottis. I have nearly always found this to succeed, and it is not a bad plan to follow systematically. The inexperienced sometimes enter the ventricles of the larynx if they diverge from the middle line. (2) In introducing the tube, membrane may be dislodged into the trachea, causing fatal dyspnœa unless tracheotomy be performed at once." Dr. Codd adds: "I have never had any cases dying from this cause. In the cases that have died or stopped breathing during the operation, I have failed to enter the larynx, and got into the œsophagus; and, owing to the suddenness of the symptoms, I am inclined to attribute them to syncope, though they might probably be due to the completion of the stenosis by the tube lodging in the œsophagus and pressing on the larynx from the back." Dr. Goodall admits that the displacement of false membrane before the tube may occur, and that tracheotomy, requiring rapid execution, under these circumstances may be required. (3) There may be great difficulty in getting children to take sufficient food, as swallowing is for the first few days much embarrassed. The importance of sufficient food being taken has already been alluded to (p. 635). (4) Parts of the liquids taken find their way into the air-passages. Dr. Codd considers the latter "a theoretic objection." The difficulty in feeding can be met by the Casselbury method: "The child is placed on the nurse's lap, the head being down, and fed with a spoon, so that it swallows uphill." In Dr. Goodall's opinion, ample nutriment can be given either by a tube passed through the nose into the stomach, or by rectal feeding. (5) The tube may be coughed out. In such cases, if the medical man is absent, death may occur in a few minutes. Dr. Goodall found that the tube was coughed up or pulled out by the patient in 28 per cent. of his cases. "Dyspnœa by no means always returns at once, and when it does there is ample time for the medical officer to reach the patient and re-insert the tube or perform tracheotomy. Intubation cases doubtless require the medical officer to be more at their beck and call than do tracheotomy cases; but this cannot be claimed as a serious objection." (6) The tubes are

symptoms, attributed to ulceration from pressure. In one case this diagnosis was confirmed by the subsequent development of stenosis. He advises that the portion of the tube between the neck and the body be coated with gelatin, into which, while it is still soft, powdered alum is pressed in. This proves simple and effective, and is recommended in all cases where the intubation has lasted over a hundred hours, and where pressure ulceration is suspected. He considers that by following this rule secondary tracheotomy will usually be avoided.

liable to become plugged with membrane. In Dr. Goodall's cases sudden blocking of the tube occurred in 12 per cent. He considers that in hospital practice there appears always to be time for a medical man to reach the patient early enough to remove the tube, and, if needful, open the trachea successfully. Recently special patterns of wider tubes have been recommended for use in cases where there is much loose membrane or discharge. Dr. Codd recommends "short cylinders. The largest possible size should be used and wedged into the larynx, and retained only a few hours at the most."*

Any one wishing to contrast fairly and practically the two operations of tracheotomy and intubation should consult a paper by Dr. R. W. Lovett, of Boston (*Med. News*, Aug. 27, 1892). From the above paper of Dr. Lovett, it is clear (i.) that intubation does not compare favourably with tracheotomy, as (a) the death-rate of intubation is 9 per cent. higher, and (b) accidents are much more common during intubation. It must be remembered here that in each case the operation was performed by especially experienced hands. (ii.) That if tracheotomy only is performed it should be a primary operation.

Dr. Lovett considers that intubation fails in being as successful as tracheotomy for saving life in severe laryngeal diphtheria for the two following reasons, namely, (1) the amount of food taken is much more limited in most cases of intubation. To this point I have already alluded at pp. 635 and 642. (2) Intubation does not afford such good drainage to the trachea. After tracheotomy large quantities of mucus, pus, and diphtheritic membrane are expelled through the tube for several days. After intubation this does not occur. The above material may be swallowed, or it may be inhaled, but it is not often expectorated. This material is highly infective, and its retention must be harmful.

One of our chief English authorities, G. A. Wright, of Manchester, gives the following opinion (Ashby and Wright, *Surgical Diseases of Children*, p. 347):—"We have had some experience of the method in various forms of laryngeal obstruction, and have not been led to take a very favourable view of its suitability for cases of diphtheria where false membrane in any quantity is present. Of 11 cases of intubation under our care, in 3 success followed, in 3 tracheotomy was subsequently successfully performed, and in 4 instances the children died in spite of tracheotomy. The operation appears best adapted for cases where there is little or no false membrane, *i.e.*, certain types of acute laryngitis, the less severe forms of diphtheria where tracheotomy is for any reason undesirable, and for use in cases where mechanical obstruction remains after tracheotomy, or results from cicatricial contraction in the larynx. It is certainly unsuitable for bronchitic or pneumonic patients." Dr. Goodall in discussing the indications for intubation and tracheotomy considers that even cases with abundant faucial membrane are not

* The question of traumatism has already been referred to at p. 640, and Dr. Goodall's opinion given. It is obvious that in hands less skilled than his ulceration and stenosis may occur, especially if the practitioner be prevented from visiting his patient at the time required. A case of fatal ulceration is candidly recorded by Dr. F. W. Carr (*Lancet*, vol. i. 1891, p. 713). The tube used here was "somewhat large," a smaller one having been coughed out.

necessarily excluded from intubation "provided that there are no symptoms of profound toxæmia, and no œdema of the fauces to obstruct the upper opening of the tube *in situ*." With regard to the number of insertions of the tube that may be made before tracheotomy is resorted to, he would rule that "if three insertions, each of several hours' duration, fail to cure the obstruction, tracheotomy should be performed."

While Dr. Codd in his candid and helpful paper ("Intubation of the Larynx," *Birmingham Med. Rev.*, Aug. and Sept., 1898) has no hesitation in declaring that intubation is by far a better operation than tracheotomy—emphatically so in hospitals, and, he believes, also in private practice—his results scarcely bear this out. Of 26 cases of intubation for diphtheria, 14 were fatal. All were treated with antitoxin. With regard to these results, which cannot be compared with those given by tracheotomy, combined with serum-treatment, in a large hospital at the present day, it is noteworthy that they are the outcome of the work of an operator who has evidently taken up the subject with much zeal and ability.

In my opinion, it is clear that while in those institutions where a special knowledge of the diseases which call for intubation exists, and where a mastery of the details needed can be obtained owing to the staff changing at long intervals, intubation at the present day will give as good results as tracheotomy, as shown by those obtained by Dr. Goodall and Dr. Waxham (*vide infra*); this is not the case in those hospitals where the service changes more frequently. In private practice it appears to me unsuitable. I am well aware that with regard to these points the mortality has of late diminished considerably, especially with the aid of antitoxin. The fact, however, remains that the accidents so candidly published by Dr. Lovett and others are grave and numerous. If such was the case with intubation "performed under most favourable circumstances, as far as a specially well-equipped hospital and very experienced attendants went" (Lovett), what is likely to be the result if intubation be attempted by those who can have no special experience, called as they are to employ this mode of treatment only occasionally, and then in times of great emergency? I am aware that these last words apply to tracheotomy also, but this, I submit, though a difficult operation, is not one requiring the same special experience and skill. It is only fair to add that the introduction of antitoxin has led to the same improvement in the results of intubation for diphtheria as it has in those of tracheotomy (p. 626).

Dr. T. H. Halsted (*New York Med. Journ.*, vol. lxx., No. 24, 1897) compared intubation before and after the introduction of antitoxin, with the following conclusions:—(1) Laryngeal diphtheria in any epidemic is never mild, but has always had a mortality of from 90 to 95 per cent., reduced by operation to from 72 to 76 per cent. (2) His report shows a mortality after intubation, without the use of antitoxin, of 76 per cent.; in cases of intubation treated with antitoxin of 25 per cent.; and in cases of death within twenty-four hours of injection a mortality of 10 per cent. The reduction of the mortality from 76 to 10 per cent. is to be attributed to antitoxin. (3) Antitoxin should always be injected as early as possible, and, in laryngeal cases, without waiting for the bacteriologist's report. If this be done it will usually prevent extension

to the larynx, or, if the larynx be already invaded, an early injection will frequently cure without an operation. No child should be allowed to die of laryngeal stenosis without an operation, preferably intubation; and serum should be injected at once, regardless of the stage of the disease, as most desperate cases often end in recovery.

Dr. F. E. Waxham reports (*Archiv. Pædiat.*, vol. xv., No. 3, 1898) a series of 29 consecutive intubations for diphtheritic laryngitis, with 27 recoveries, all having been treated with antitoxin.

Technique of Intubation.

O'Dwyer's Method.—To prevent movements of the child,* it is wrapped securely in a blanket, and placed in an upright position on the lap of a nurse, the head resting on her left shoulder. The nurse holds the child's upper limbs securely with her hands, and the lower ones with her knees. An assistant standing behind, and to the left of the nurse, holds the head of the child inclined somewhat backwards, perfectly steady, and towards the operator. The latter, seated so as to face the patient, opens the mouth widely with a gag. At this stage the struggles of the child may so increase the respiratory distress that instant performance of tracheotomy is demanded. Cardiac syncope is now especially to be feared. The operator next, while his right hand holds an introducer with the tube of appropriate size fitted on and threaded, with his left index finger, protected with a finger-stall or a sealed gauze-dressing, hooks up the epiglottis. The position of the glottis being thus localised, the tube is carried along the inner side of the left index, and then downwards and forwards by raising the handle of the introducer, which must be carefully kept in the middle line. When the tube is in place the left index finger gently pushes it down, and at the same time the introducer is withdrawn, the handle being gradually depressed. George Wright (*loc. supra cit.*) gives a point of much practical importance here: "Any difficulty in introducing the tube may, we have found, be got over by waiting for an inspiratory effort on the part of the patient, and then slipping in the tube." With his left index the operator then makes sure that the tube is in place, by feeling the posterior wall of the larynx between his finger and the tube. If this is not the case the tube will be found to be in the upper part of the œsophagus; it can be removed by the string, and the operation repeated.† Expulsive coughing and a peculiar rattling of mucus which immediately follow the introduction of the tube and the withdrawal of the finger usually denote that the tube is safely *in situ*. The gag is now withdrawn, and the child allowed to breathe quietly for a few minutes. If there be no obstruction to respiration the gag is again inserted, and the left index finger being placed on the head of the tube, so as to prevent its being displaced, the thread is withdrawn. George Wright (*loc. supra cit.*) is of the opinion that "it is much better not to withdraw the thread, so as to facilitate extraction; usually it sets up little or no irritation."

* Dr. Codd, to prevent syncope, introduces the tube with the child in the recumbent position.

† Dr. Codd's advice here is to be remembered: "If you fail to hook up the epiglottis or get the tube into the larynx at the first effort, withdraw the finger, and, after a short interval, re-insert it. Do not make prolonged efforts."

Withdrawal of the Tube.—Two points call for consideration here : (a) *the date at which the tube may be dispensed with* ; (β) *the mode of withdrawal of the tube*.

(a) *The date at which the tube may be dispensed with.*—No hard and fast rule can be laid down here. The following data (F. Wright, *loc. supra cit.*) will help in a decision : (1) The earlier antitoxin has been administered, the earlier will the membrane be loosened, and the sooner may the tube be removed. (2) A temperature falling to 99° or lower. (3) A generally satisfactory condition of the child. (4) If, in spite of every care in feeding the child, both in the recumbent (p. 642) and the erect position, food is badly taken, this, *cæteris paribus*, is an indication for removal of the tube. Dr. Codd (*loc. supra cit.*) says on this point, "As a general rule four days suffice to leave the tube in, though re-intubation is often necessary." Carefully drawn-up tables by Dr. Goodall "point to the advisability of not removing the tube till the lapse of from thirty-six to sixty hours."

(β) *The mode of withdrawal of the tube.*—This is somewhat more difficult than intubation. In the latter the operator has the tube under his command ; in its withdrawal he has to get command of it (F. Wright). The position of the patient being the same, the surgeon hooks up the epiglottis with his left index, and rests the tip of the finger on the posterior part of the head of the tube. The curved extracting forceps is passed along the palmar aspect of the finger, being kept strictly in the middle line until it reaches the tube just in front of the finger. The handle of the extractor being gently raised, its point, aided by gentle movements of the left index finger, now finds the entrance into the tube and is dropped into it. The right thumb now presses on the spring, separates the blades, and the tube is withdrawn. Previous to introducing the extractor, the amount to which its point can be opened out must, by means of a screw on the under-surface of the instrument, be carefully adjusted to the size required for the removal of the tube, otherwise much injury may be inflicted on the soft parts about the upper orifice of the larynx.

Intubation in Chronic Stenosis.—The tubes for the treatment of this condition are made in vulcanite as well as in metal. Intubation by means of these tubes, if obtainable, will be found preferable to the use of the gum-elastic ones of Macewen in the case of adults. The full account already given above will suffice here also.

OTHER INDICATIONS FOR TRACHEOTOMY.

(i.) **Syphilitic and Tubercular Ulceration.**—Of these tracheotomy is the more frequently called for in *syphilis*, in which also it is decidedly more useful. The conditions which demand it *temporarily* are, œdema of the glottis, setting in on old mischief ; fibroid thickening, which may later yield to treatment ; and more *permanently*, probably, deep ulceration, necrosis, and cicatricial contraction.

In *tubercular mischief*, tracheotomy rarely gives much relief, dyspnœa being now a rarer misery than cough and difficulty of swallowing, both of which are conditions which may be intensified by the presence of a tube.

(ii.) **Malignant Disease of the Larynx.**—This subject is considered below (p. 654).

I would take this opportunity of urging strongly that in all cases of tracheotomy where dyspnœa is present or likely to be brought on by the anæsthetic, save in little children (p. 631), local analgesia, by means of eucaine and adrenalin, should be employed (p. 650). I refer especially to tracheotomy for disease of the larynx, malignant bronchocele, and other growths which have caused narrowing of or a liability to spasm in the air-passages.

(iii.) **Acute Laryngitis.**—The rapidity with which this may run a fatal course, especially after exposure to cold in reduced constitutions, is well known. If treatment, including scarification of the aryteno-epiglottidean folds and adjacent parts, fail to relieve the dyspnœa, tracheotomy should be performed at once to meet the increasing exhaustion.

(iv.) **Certain Spasmodic Affections—e.g., Thoracic Aneurysm and Tetanus.**—Owing to these diseases destroying life usually in other ways, tracheotomy is rarely called for here. Occasionally, however, the laryngeal dyspnœa which they may bring about calls for this operation.

Probably there is no form of dyspnœa more agonising to the patient, or more distressing to the friends, than that which may accompany **thoracic aneurysm**. The surgeon, however, when called upon to perform tracheotomy in one of these terrible cases, must remember that the dyspnœa may be due to direct pressure upon the trachea as well as to pressure or irritation of the laryngeal nerves, that it is in the latter only that operation will give relief, and that the difficulty of distinguishing between the two, though much diminished by the laryngoscope, is not entirely removed.

I would refer my readers on this point to one of the late Dr. Bristowe's interesting Lumleian Lectures,* and especially to the following passage: "Destruction of the functional activity of one recurrent laryngeal nerve is attended with, of course, paralysis of the corresponding vocal cord (which can be recognised by means of the laryngoscope), with impairment of the musical quality of the voice, and apparently with some difficulty of swallowing, owing to the tendency of food to slip into the trachea, but is certainly not necessarily attended with stridor or dyspnœa; in the second place, compression of the trachea involves stridor and dyspnœa, which is often paroxysmal and is liable to end in sudden death, but does not itself interfere with intonation or phonation, excepting in so far as it may render the voice weak by diminishing the supply of wind to the vocal organ." As the paroxysmal nature of the dyspnœa may thus be met with in cases of pressure on the air-tube below the larynx as well as in laryngeal dyspnœa, the chief points to rely on will be the result of a laryngoscopic examination and the freedom of the lungs and air-tube from pressure. Dr. F. de H. Hall† thinks that "the absence of respiratory

* *Lancet*, May 18, 1879. Dr. Bristowe went on to show that the exacerbations of dyspnœa in narrowing of the trachea may be due partly to spasm of the muscular fibres, but mainly to accumulation of mucus below the narrowing, and to the difficulty of dislodging it by coughing.

† *Clin. Soc. Trans.*, vol. xix. p. 82. Quoting from Gerhardt (*Lehrb. d. Ausc.*, Tübingen, 1871), Dr. Hall points out that in a case of aortic aneurysm the following causes for

excursions of the larynx" points to the chief impediment being below the glottis.

With regard to tracheotomy in **tetanus**, the same warning has to be given. In the rarer cases in which tetanus threatens life by asphyxia and not by exhaustion, the surgeon, before performing tracheotomy, must decide where lies the seat of the asphyxia. In the few cases that I have seen in which asphyxia closed life in this disease, the asphyxia was due to spasm of the muscles of respiration, including the muscles of inspiration and those of expiration—*e.g.*, the abdominal muscles also. The fatal spasm thus usually not lying in the larynx, tracheotomy seems contraindicated, unless it were done with the object of relieving, with the aid of artificial respiration, that congested, gorged condition of the lungs which is due to the continued spasm of the muscles of respiration. And it is to be feared that if these steps were taken, the gentle violence of artificial respiration would, as has happened with tracheotomy itself in this disease, only bring on further, and perhaps final and fatal, spasms.

(v.) **Scalds of the Upper Aperture of the Larynx.**—Tracheotomy is here usually deferred until late, and its want of success is well known. This is not, however, an instance of cause and effect, the mortality in these cases being rather due to the shock, pain, and inability to take sufficient food. Unless the patient is seen late, tracheotomy should not be performed in these cases till a trial has been made of scarification, or rather of acupuncture, by means of a guarded bistoury point, of the mucous membrane of the epiglottis and the glosso-epiglottidean and aryæno-epiglottidean folds, the left forefinger guiding the point of the instrument. In doing this the surgeon must remember the amount of dyspnœa which is already present, and the certainty that this will be increased by the struggles of the child, by the finger coming in contact with the inflamed parts; at any moment the child must be turned on its side, artificial respiration performed, or tracheotomy at once resorted to.

(vi.) **Foreign Bodies in the Air Passages.**—We will suppose a child brought to the surgeon with a history of having swallowed one of the usual foreign bodies. Two questions now call for an answer: (1) Is there a foreign body at all in any part of the air passages? and (2) if so, where is it? In regard to the first question, it is well to remember that the history is often far from clear, especially in children, and the symptoms by no means so obvious as they are often described to be. Thus, the chief aids in distinguishing the entrance of a foreign body from such a disease as membranous laryngitis are the sudden onset and, not unfrequently, the well-marked intermissions. The symptoms characteristic of the entrance of a foreign body into the larynx—*viz.*, the urgent dyspnœa, the cyanosis, the struggling against

dyspnœa (Sir D. Powell, *Reynolds' Syst. of Med.*, vol. v. p. 32) may all be present together: (1) Undoubted paresis of the abductors of the cords. (2) Though the necropsy may "not show any very distinct bulging inwards of the trachea, the aorta and sac being emptied of blood, yet I can readily believe that during life, when these parts were distended with blood, considerable pressure was exerted on the trachea, and that this narrowing led to accumulation of the tough mucus which so bothered the patient." (3) Gairdner (*Clin. Med.*, p. 486) states that paroxysms of dyspnœa, closely resembling those of asthma, may be occasioned by compression of one of the pulmonary plexuses.

impending death—may not be got at on account of the youth of the patient, or because no one saw the onset; while if the body has passed from the larynx into the trachea, or into one bronchus, the dyspnœa, brassy cough, and alteration in the voice may all have disappeared before the surgeon sees the child, and yet he will be expected to give a definite opinion. Again, the body may have been coughed up, or perhaps swallowed. Finally, in adults, usually hysterical and egotistical women, who come with a history of cancer, dysphagia, &c., owing to a pin which they aver to be in their throats, the diagnosis will sometimes be far from easy.*

Having settled that a foreign body is really present, the surgeon, unless tracheotomy is urgently called for, tries to decide where the body is lodged. A careful examination should be made in a good light, with a finger in the fauces, the laryngoscope being employed when feasible, any information about the size and nature of the body having been previously obtained.

(a) A large or irregular body, such as bolted—*i.e.*, unmasticated—food, or artificial teeth, usually lodges above the upper aperture of the larynx, and causes urgent and often fatal dyspnœa. If, however, the first attack be survived, bodies of considerable size—*e.g.*, a plate with one or two false teeth, or a halfpenny—may lodge near the base of the epiglottis and aryæno-epiglottidean folds for a very considerable time.

Such cases should be treated by laryngotomy to meet the urgent dyspnœa, and extraction of the bodies either by the finger, or appropriate forceps, or probangs.

(β) A small and light body, *e.g.*, a bead, a pea, or more likely an irregular one, as a bit of nutshell, may stick in the rima or ventricle of the larynx. If the first urgent symptoms pass off without operation,† the position of the body will be pointed to by the shortness of the intermissions between the attacks of spasm, and by the pain and the marked alteration of the voice.

The treatment here would be, first, to perform a high tracheotomy (p. 630), and to dislodge the body from below with a female catheter or a bougie of appropriate size, the cricoid cartilage being divided if needful. If the body cannot be dislodged in this way, a partial or complete thyrotomy (footnote, p. 620) must be performed (p. 660).

The following is an instance of a simple method of removing a foreign body from the sub-glottic region (Dr. Walker Downie, *Glasgow Med. Journ.*, Dec., 1904, p. 447):—

The child was two years old. Fifteen days before, noisy breathing was noticed soon after she had eaten an apple. There was no cough, no dyspnœa, no dysphonia, but the respirations were very noisy, and, while air seemed to enter the lungs equally, there was a little more diaphragmatic effort than is usual in a healthy child. No body could be seen after the performance of tracheotomy, but when a narrow strip of gauze introduced by the

* I would refer my readers to some instructive remarks by Mr. Lund on the delusive impressions which may arise from the imagined swallowing of false teeth, &c. (*Hunt. Lect.*, 1885, p. 34).

† Occasionally, when the body is in the ventricle, the consequences may be very slight for a long time, especially if it is smooth and soon coated with mucus, and partly encapsuled. Mr. Durham (*Syst. Surg.*, vol. i. p. 760) mentioned a case of Desault's in which a patient, with a cherry-stone in one of the ventricles, refused operation and lived for two years, death then taking place from laryngeal disease.

wound was slowly pulled up into the mouth, two portions of the seed-envelope of an apple were caught in the meshes of the gauze. An uninterrupted recovery followed.

(7) If the body passed through the larynx it will depend mainly on its outline and weight whether it remain in the trachea or pass into one of the bronchi. Thus, if it be light and smooth—*e.g.*, a cherry-stone—it may frequently shift its position, and then, from time to time, rising into the larynx, cause spasm, and thus attacks of urgent dyspnoea, with paroxysmal cough and temporary aphonia.

In such cases tracheotomy should be performed with a free opening into the air-tube, this being kept open by stout silver-wire ligatures passed through the edges of the wound and tied behind the neck, or a dilator such as Mr. Golding Bird's may be inserted.

(8) If the body be smooth and heavier it will probably fall into one of the bronchi. This subject is dealt with separately (p. 652).

Finally, I would urge the advisability of an early tracheotomy when there is any reason to believe that there is a foreign body in the air passages, even if no urgent symptoms be present. Dyspnoea may come on suddenly at night, and, if not fatal, may cause the shifting of a foreign body from a favourable to an unfavourable site—*e.g.*, from the upper part of the trachea to a bronchus. If, after deciding that a foreign body is present, the surgeon do not perform tracheotomy before he leaves the patient (a step to be always taken if he lives at a distance), he should arrange for the instruments, &c., being ready at hand for any emergency.

Tracheotomy under Local Analgesia.—Before leaving the subject of tracheotomy, the above must be referred to, especially in its reference to cases of chronic stenosis of the larynx. While I am not in favour of performing delicate operations under local analgesia where a general anæsthetic can be given by skilled hands, it is certain that in some cases the risk of the operation is greatly increased by the use of a general anæsthesia. I refer to cases where a patient, who has been obliged to keep in one position in order to facilitate his breathing, has a sudden attack of urgent dyspnoea when he is placed in the position for tracheotomy. Again, in some cases of marked stenosis, general anæsthesia, by abolishing the voluntary respiratory movements, may render it impossible for sufficient air to be drawn through the narrowed larynx. B. Fränkel called attention (*Berl. Klin. Woch.*, June 6, 1898) to the value of cocaine in such cases. He injected a 20 per cent. solution in two places, or a 10 per cent. in four places. In children, only the 10 per cent. solution should be used. In a few minutes tracheotomy can be performed painlessly. Fränkel never found that, under cocaine, it was necessary to complete the operation in a hurry owing to threatening asphyxia. He had thus performed tracheotomy in 17 adults—in 5 for laryngeal syphilis, in 6 for tubercular laryngitis, in 4 for carcinoma, in 1 for chronic laryngitis, and in 1 for stenosis after attempted suicide. In two other cases tracheotomy was performed for acute disease. In four cases chloroform was used, as well as cocaine. After a certain amount of anæsthesia had been induced, cocaine was injected, and the tracheotomy performed during partial narcosis.

Dr. St. Clair Thomson calls attention to the advantages of local analgesia by cocaine and adrenalin (*Brit. Med. Journ.*, Oct. 14, 1905).

The following are the details of his method:—"The first and most important point is to limit the amount of cocaine* employed. I have never exceeded 1 cg. ($\frac{1}{8}$ gr.), and have never seen the slightest toxæmia from this dose. In many cases half the quantity has sufficed. A tabloid containing cocaine hydrochloride $\frac{1}{8}$ gr., morphine hydrochloride $\frac{1}{50}$ gr., and chloride of sodium $\frac{1}{8}$ gr. is dissolved in 56 minims of sterilised water. To this adrenalin chloride, 1 in 1,000, is added in the proportion of 1 in 15, so that 4 minims of adrenalin would be contained in 60 of the prepared liquid. The skin over the trachea having been purified, a drop of pure carbolic acid is deposited on it at the two extremities of the proposed incision—that is, for high tracheotomy, over the centre of the thyroid cartilage and over the situation of the thyroid isthmus; and, for low tracheotomy, at the level of the cricoid cartilage and over the manubrium sterni. The slight eschars produced are useful guides in indicating the situation and extent of incision through the skin, and they render it so insensitive that the first prick of the needle is scarcely felt. Or chloride of ethyl may be sprayed on the skin. I have used the usual needle of an ordinary hypodermic syringe, about $1\frac{1}{4}$ inches in length. It is always at hand in emergency, and a good length of skin can be threaded on it; or the antitoxin syringe, with its 2-inch needle, can be employed. The needle having been thrust a very short way into the cutis, through the spot stained by the pure carbolic acid, a drop of the lotion is extruded, and a pause made to allow of its local action. This permits of the needle being painlessly pushed a little further and another drop being expelled. The process is repeated at short intervals until the whole length of the needle has been introduced. The proceeding is then repeated from the other carbolic spot. This injection should be carried out slowly, to allow of absorption and so avoid the painful feeling of distension.

"It is important to give sufficient time for the solution to act, and disappointing results are frequently encountered by those who are impatient. At least twenty minutes are required to obtain satisfactory analgesic and hæmostatic effects. The track of the injection is then generally blanched as if frozen, and it will be found that all the incisions are perfectly painless, particularly if a very sharp knife is used. The only discomfort experienced is in any dragging or tearing movements during blunt dissection of the layers of fascia. . . . The hæmostatic effect is remarkable. Unless the thyroid veins of the isthmus are cut across, no vessel requires clamping, and sponging is hardly needed. The adrenalin also appears to remove any remote chance there may be of such a small dose of cocaine producing any depressing action, and as never more than four drops of it are used, there is no possibility of excessive vaso-constrictor action. Although I prepare 60 minims of solution, the whole amount is not always required."

The clear details given above will be helpful to those surgeons who are about to use local anæsthesia in the cases to which I have referred, such as partial thyroidectomy in exophthalmic goitre and tracheotomy

* Eucaine as advocated by Mr. Barker (p. 652) is far preferable. As a 10 per cent. solution of this drug is its maximum, it is only when a stronger solution is required that cocaine is to be added.

where dyspnœa is already present, or where it is likely to arise if a general anæsthetic be given. With regard to the use of local anæsthesia in children, especially when dyspnœa is already present, Dr. St. Clair Thomson, following Fränkel in some of his cases, suggests that only sufficient chloroform be given to quiet the child, the cocaine-adrenalin injection being then made. For my own part, I should greatly prefer at this age the administration of a little chloroform by careful hands, as long as certain common-sense precautions are taken. Of these the chief are, allowing the child to commence the inhalations in a comfortable position, not straightening out the neck until sufficient insensibility has been produced, and not commencing the administration until the surgeon is ready to proceed at a moment's notice.

Dr. St. Clair Thomson acknowledges his indebtedness to Mr. Barker's excellent paper on Local Analgesia (*Brit. Med. Journ.*, 1904, vol. ii. p. 1682).

The following solution is recommended by Mr. Barker:—

"Distilled water	. . .	100 c.cm.	= 3½ oz.
β eucaine	. . .	0.2 gram	= 3 grains.
Sodium chloride	. . .	0.8 gram	= 12 grains.
1 pro mille adrenalin chloride solution	. . .	℥ x.	

The actual strength in this solution is 1 in 200,000. All this quantity of fluid can be used in an ordinary case if necessary, and is quite sufficient for most. But I have often injected twice as much when large areas had to be dealt with, and have seen no ill results from the six grains of eucaine or ℥ xx. of adrenalin." A little light food should be taken before the local analgesia.

FOREIGN BODIES IN THE BRONCHI.

Amongst these may be tracheotomy tubes,* especially ill-made ones; tubes worn too long, particularly if a low operation has been done (p. 630); pebbles; fruit-stones; parts of toy whistles; pieces of nutshell, &c., &c.

Site of Lodgment.—From the statistics of Bourdilat (Cohen, *loc. supra cit.*), Gross (Durham, *Syst. of Surg.*, vol. i. p. 758), and Goodall, it would appear that the trachea, larynx, and right bronchus,† owing to

* Dr. Cohen (*Internat. Encycl. Surg.*, vol. v. p. 665) thus speaks of the frequency with which these bodies have slipped in when ill made or corroded: "This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasise the point with quite an array of references" (*q.v.*).

† While this is the rule, Dr. Cheadle and Sir T. Smith reported (*Lancet*, Jan. 14, 1888) a case of occlusion of the left bronchus by a metal pencil-cap in a girl aged 9. Urgent dyspnœa followed at once, relieved by the passage of an œsophageal probang, the foreign body being believed to have entered the stomach. There was great pain at the time, and violent cough. By the eleventh day there was evidence of almost complete collapse of the left lung, this having commenced on the fourth day. There was no dyspnœa, but occasional short cough. The cap was believed to have lodged at the end of the left bronchus. Tracheotomy was performed through the thyroid isthmus, divided between two ligatures. The trachea was freely opened, and its edges sutured to the skin. A long probe detected the cap in the position diagnosed, with the open end uppermost. It was easily extracted with suitably curved forceps. A good recovery followed.

its larger size, and the septum being a little to the left, are the most likely places in which a foreign body will be arrested.

Evidence of a Foreign Body having lodged in a Bronchus.—Perhaps there may be a history of a foreign body held in the mouth; pain, dull and heavy, behind the sternum, at about its junction with the second right costal cartilage*; shortness of breath; cough; expectoration; more or less diminution of breath sounds over a portion of the chest wall†; râles; increased breath sounds on the opposite side; and, later on, evidence of inflammation and destruction of lung tissue.

Treatment.—A low tracheotomy (p. 630) should be performed at once, and with as free an opening as possible. The edges of the incised trachea being held open with sutures of wire (not too fine), inversion and succussion should be tried, and a feather or probe passed in order to excite cough.

If provided with suitable instruments (see below) the surgeon may at once proceed to attempts at extraction, but it is well to remember the fact pointed out by Mr. Durham (*loc. supra cit.*, pp. 769, 770) that in a large proportion of the cases which have done well expulsion has not been effected until some time after the operation.‡ Whenever a fit of coughing brings the body into view, the next inspiration will draw it back again, so that careful watching and prompt use of forceps, &c., will be required.

If from its shape, or from the interval which has elapsed, the body is too firmly impacted to be expelled by exciting coughing, the following instruments should be resorted to—viz., Gross's flexible German-silver tracheal forceps, long and slender and easily bent into any curve; or Durham's forceps, equally flexible and giving a better grip. Another forceps which has proved itself most useful in these cases is Tait's alligator forceps (see section on cholecystotomy). Mr. R. Anderson, of Nottingham, gives an instance of this (*Brit. Med. Journ.*, April 12, 1902) in the removal of a nail from the right bronchus of a child æt. 2½.

The Röntgen rays showed the presence of a nail—this had been "swallowed" six months previously—a little to the right of the middle line, passing downwards and outwards from the level of the third costal cartilage. After the performance of a high tracheotomy the nail was felt with a probe 3½ inches from the wound. After unsuccessful attempts with other forceps, the foreign body was easily extracted with alligator forceps.

* The division of the trachea is opposite the spine of the third, in some cases the fourth, dorsal vertebra. In front, this division is on the level of the junction of the first with the second bone of the sternum. The root of the spine of the scapula is on a level with the third intercostal space. A stethoscope placed here would cover the bronchi, more especially the right (Holden).

† "Obstruction of the left bronchus usually produces absence of respiration over the entire lung of that side, but occlusion of the right bronchus usually produces absence of respiration over the lower lobe of that side only, the division of the bronchus taking place much nearer the bifurcation, and the foreign body rarely lodging above the point of division" (Dr. Cohen, *loc. supra cit.*, p. 671).

‡ Thus, in a case of Dr. Smith's at Halifax (*Lancet*, 1876, vol. ii. p. 148), a boy, aged 8, swallowed a whistle (as thick as a penholder, and about half an inch long) on Jan. 8; it was not expelled till May 7, the child having, for the previous six weeks, had increasing cough and expectoration with progressive emaciation. The boy recovered, and Dr. Smith draws attention to the fact that, owing to the very slight discomfort, it is doubtful if the cause would have been recognised if the impacted body had not produced a whistling sound, and thus demonstrated its presence.

The nail lay head downwards. No sutures were inserted. The recovery was uninterrupted. The absence of any physical signs enabling Mr. Anderson to say in which bronchus the nail lay was perhaps explained by its lying obliquely.

Mr. W. M. Willis (*Lancet*, 1904, vol. ii. p. 1641) mentions another case in which the same forceps, after a low tracheotomy in a child aged 7, quickly removed a fruit stone from the right bronchus.

Failing the above, stout silver or copper wire should be bent into the form of a blunt hook, or a long probe fashioned into the same shape.* The above instruments are first used as sounds and searchers, aided by the forefinger, which can be passed as far as the bifurcation of the trachea and the orifice of each primary bronchus, as pointed out by Dr. Sands, quoted by Mr. Durham (*loc. supra cit.*, p. 771).

The operation should not be too prolonged, especially if the parts are inflamed. When this condition has subsided, spontaneous expulsion will often take place. Prof. Annandale (*Med. Times and Gaz.*, Feb. 27, 1875) recommends that this be promoted by the patients taking a deep inspiration; the surgeon then closes the tracheotomy wound till expiration, thus rendered more violent, follows, and often drives out the body.

EXTRA-LARYNGEAL OPERATIONS FOR REMOVAL OF GROWTHS OF THE LARYNX, EXCISION OF THE LARYNX, PARTIAL AND COMPLETE.

It will be seen from the remarks made below that the value of some of these operations is still *sub judice*; much of the following will, therefore, require confirmation.

Indications.—Carcinoma and sarcoma of the larynx, especially if intra-laryngeal in origin, and remaining so. This being the chief and almost the only indication for operative interference, any others will be very briefly alluded to (p. 676).

The following questions call for an answer when the question of operative interference arises in the case of growths of the larynx: A. *Is the disease malignant?* B. *How far has it advanced?* C. *Is it now intra- or extra-laryngeal, and where did it originate?* D. *Which of the following operations is the wisest to be prepared for when the local condition of the growth and the general condition of the patient are duly weighed, thyrotomy, removal of the larynx, partial or complete, trans-hyoid pharyngotomy, or a palliative tracheotomy?* To give any helpful answer here, (1) the results of these operations and (2) the after-condition of the patients have to be duly weighed. There is scarcely any decision in surgery which is so beset with difficulties.

A. *Is the case one of malignant disease?* and, if so, B. *how far has it advanced?* The impossibility of always deciding early and positively whether a growth in the larynx is malignant by the laryngoscope alone was proved by the case of the late Emperor of Germany. As in

* Mr. Hulke (*Lancet*, 1876, vol. ii. p. 785) used a long piece of German-silver wire, one end of which was formed into a blunt hook about one-eighth of an inch long, and the wire again bent about an inch and a half above this, at an angle roughly estimated as that which the right bronchus and trachea include. The other end was fashioned into a large loop, the plane of which coincided with that of the tracheal end of the wire beyond the angle, and thus allowed it to be guided into the right bronchus.

the case of the tongue, in a certain proportion of cases it is impossible to say whether the trouble is papillomatous or epitheliomatous, if the former whether it is in the pre-cancerous condition, *i.e.*, its base richly cellular; in other occasional cases, as in the tongue, whether an ulcer is carcinomatous, syphilitic, or tuberculous.*

This difficulty raises the question of the value of previous intra-laryngeal removal of portions of the growth for examination. As in the tongue, there are certain cases in which this step will not clear up the doubt, either because the incision does not happen to have been made deep enough to reach the part where malignancy is present, or because it has entered a part adjacent to it. Moreover, this mode of intra-laryngeal removal of bits of growth is not without its risks. Dr. Newman, of Glasgow, sounded the following note of warning (*Clin. Soc. Trans.*, vol. xxii.): "Intra-laryngeal excision for microscopic purposes exposes the patient to very serious dangers by increasing the rapidity of secondary new formations. The incision of a cancerous growth, or its partial removal, has justly been regarded as a most dangerous procedure, probably because the absorption of the infective material takes place rapidly from a wounded surface. For instance, judging from my own experience of other similar cases, I should say that neither in case 2 nor 3 would the lymphatic glands have become involved for months had I not removed portions of the growth with forceps. In both cases the tumour was limited in size, and in both, within a very short time of the intra-laryngeal operation, the lymphatic glands became involved. . . . While conscious of the value of removing portions of a laryngeal neoplasm for diagnostic purposes, I desire to express my strong conviction that it should not be resorted to in cases suspected to be cancer unless the patient is willing to have a radical operation performed immediately after the diagnosis is completed." As bearing on this subject, I may refer my readers to the case mentioned at p. 221.

In the third edition of this book I urged early thyrotomy, a step advocated in 1889 by Mr. Butlin, who has done more than any one else to elaborate this operation.

It seems to me that we should face this difficulty, which will always lie before us, in the same way as we do elsewhere. Where a patient has suspicious symptoms, especially at a suspicious age—*e.g.*, alteration in the voice, "soreness," pain, cough, hæmorrhage, interference with breathing or swallowing—we should adopt the same steps which stand us in such good stead in cases of doubtful malignant disease elsewhere, and explore. Where such interests are at stake, there should be no hesitation in advising opening of the thyroid cartilage and examination of the larynx. If the growth is malignant, one of the

* In Mr. Butlin's words, "There are three classes of cases, the first in which every one can make a diagnosis, the second in which the more experienced can make it, and the third class in which the conditions are so obscure that no one can make a diagnosis unless the larynx is opened, and in some of which it is even then difficult to say what the nature of the disease is." Dr. C. Jackson, of Pittsburg (*loc. infra cit.*), considers the last class "an exceedingly small one if we are allowed to exclude syphilis by the therapeutic test." On this point he warns us that potassium iodide may cause acute cedema in specific, malignant, and tubercular disease. He has had to perform tracheotomy for this seven times. His remarks on diagnosis are very full and helpful.

operations mentioned above should be proceeded with at once, or a preliminary tracheotomy alone performed at this stage. If the disease is not malignant, it will very likely be the better for local treatment, which can now be effectually applied. If the thyroid cartilage be very carefully divided in the middle line, and no further operation done, we know from our experience, in adopting a similar step for the removal of certain foreign bodies, that no harm will happen to the cords, while the relief to the patient's mind will be enormous. It is only by this early and complete exploration that we can hope to attack the disease in a stage when it can be entirely removed.

B. *How far is the disease, if malignant, advanced?* To this, again, an answer can only be given by thyrotomy. Here the warning of Sir F. Semon (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1116) is to be remembered, that when the larynx is opened the disease is almost always found to be much more advanced than one would have thought from the laryngoscopic inspection.

C. *Is the disease intra- or extra-laryngeal?* The importance of this distinction—one not always possible to make—is enormous, owing to its bearing on the severity of the operation and its results, immediate and later.

Under the term *intrinsic carcinoma* should be included those cases in which the disease has begun in and is confined to the cavity of the larynx proper from the cords downwards. The *extrinsic group* should include these cases where the growth has started in the epiglottis, or aryæno-epiglottidean folds, or cricoid,* or when, having begun in the pharynx, it has invaded the larynx, or *vice versa*. Here another warning is needed. In some cases it may be only possible to clear up this point at the operation. This was so in a case of Mr. Holmes's, one of the earlier ones operated on (*Brit. Med. Journ.*, vol. ii. 1884, p. 809). In two cases recorded by Mr. Harvey (*Lancet*, Sept. 21, 1901, p. 782), it was found during the operation that the growth had made its way from the larynx into the neck through the posterior part of the cricothyroid membrane.

It was shown by Krishaber and Fränkel that the *intra-laryngeal form of carcinomata* remains limited to the larynx for some time, and, while so limited, is comparatively slow in affecting the glands.† *Extrinsic carcinomata*, on the other hand, affect the glands at an early stage. The laryngeal *sarcomata*, though rapid in growth and with marked power of infiltration, have no marked tendency to spread by the lymphatics and affect the glands, thus affording an instance of the well-known variableness of sarcomata in this respect.

In deciding whether the disease is extra-laryngeal, the surgeon may be helped by a history of dysphagia, the passage of a bougie, by noting

* Of those extrinsic carcinomata which begin in the laryngeal region, but not in the larynx proper, Dr. Chevalier Jackson (*Trans. Amer. Lar. Soc.*, 1904, p. 165) finds that the posterior surface of the cricoid is by far the most frequent site. The importance of this is shown by Mr. Harvey's cases.

† While those who have worked at this subject are not agreed as to the exact lymphatic supply of the larynx, they are unanimous in declaring that the vocal cords are less richly supplied than the vestibular regions, and that the lymphatics of each half of the larynx are relatively independent of each other. Further, there is reason to believe that carcinoma is somewhat slow in destroying the cartilages.

the mobility of the larynx* laterally on manipulation and in deglutition, the involvement of lymphatic glands, and the date at which this involvement has taken place,† and by information gained by the passage of a finger from the mouth with the aid of eucaine. Dr. Newman, in his instructive book (*loc. supra cit.*), writes: "When the disease is intrinsic, the prominent symptoms are aphonia and dyspnoea. The lymphatic glands are seldom affected; as a rule, cachexia is not a prominent feature during the earlier stages of the disease, and dysphagia is not a common symptom. In patients suffering from extrinsic growth, on the other hand, aphonia is not usually present at the commencement of the disease, and, indeed, there may be only slight alteration in the voice, while dysphagia is, as a rule, present as soon as the growth has reached any considerable size. Pain in larynx and pharynx, extending round the neck and to the ear of the affected side, is more characteristic of extrinsic than of intrinsic new formations. In the former the glands are also involved at an early period, and cachexia is usually pronounced."

While the subject of *extrinsic malignant disease of the larynx* is being referred to, the question of *how far operations in these cases are justifiable* arises. Interference here is one of those instances in which the surgeon may have a difficulty in deciding where to stop, owing to the extent of the disease. Where the pharynx, epiglottis, and surrounding soft parts have been extensively extirpated, the patient usually gains a prolongation of life, rarely a cure, at the cost, to put the matter moderately, of great discomfort. In the words of Dr. Cohen, of Philadelphia (*Intern. Encycl. of Surgery*, vol. v. p. 776), it is most important to distinguish between "recovery" and mere "survival" after operations in these cases. To enable my readers to form an opinion for themselves on this matter, I will refer them to the illustrations accompanying Prof. Gluck's article (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1122), and more particularly Figs. 19, 22, 23, 24, 25. The results demonstrate what especial experience may achieve with especial operative skill, but this is only half the picture. Such figures as the above, showing the steps in the technique by which such results may be attained, show also inevitable mutilations by which the patient's future must be rendered a sad one. Prof. Gluck's words (p. 1123), "First save and prolong the life of your patient, and do not trouble yourself too much about the post-operative state; the restitution of function will be a secondary care, the imminent danger once dissipated," are justified as far as they go, but they do not go far enough. His success seems to have begotten an enthusiasm leading him to forget that it is the patient, and not the surgeon, who will have reason "to trouble about the post-operative state," and that the degree of "restitution of function," the organs—for it is not only the larynx which is concerned—being most essential for the

* The larynx may be movable and yet the pharynx be implicated, as in a case reported by Surgeon-Major Macleod (*Lancet*, April 26, 1884).

† Dr. C. Jackson, in his remarks on infiltration of the glands (*loc. supra cit.*), warns us, "If no adenopathy can be made out even deep along the trachea and œsophagus, it does not exclude carcinoma, even if the growth be ulcerating." One of Dr. Durante's cases (p. 672) bears on the correctness of this observation.

daily comfort of the patient, is, in the great majority of those who survive, very incomplete. Any one familiar with the literature of this subject will agree with me that this aspect of the case does not receive its rightful prominence with many writers. Without the least exaggeration, the fact remains that of all the mutilations inflicted by surgery that for extrinsic malignant disease is one of the most terrible.

The most that can be said—and it is only fair to give both sides—is that if the patient survive he will be freed from pain, especially pain in the ears, from much of his cough, from toxæmia, and he will put on flesh. How far he can follow any occupation must depend upon the nature of this, and how far it requires the ordinary voice which has been lost.

While the decision here must be left to the patient, and while especial indications for running the necessary risks will occasionally arise, *e.g.*, in the case of a pension, annuity, etc., there is scarcely any question in surgery which is so beset by difficulties.

D. *Which of the operations open to the surgeon is it wisest to perform in cases of intrinsic malignant disease?*

Here, in addition to the conditions presented by the growth in each individual case, (a) the state of the patient as to general vitality and the condition of his viscera, especially the lungs, (b) the results of the operation, and (c) the after-condition of the patient, have to be considered.

The operations are the following:—(i.) thyrotomy; (ii.) unilateral removal of the larynx; (iii.) complete removal; (iv.) trans-hyoid pharyngotomy; (v.) palliative tracheotomy.

(i.) **Thyrotomy.**—While this term is retained for the sake of convenience, it is here an incomplete one. Not only is the thyroid cartilage and, if needful, the cricoid divided as in the removal of certain foreign bodies, but the growth, and with it a varying part of the larynx, is removed as well, the framework of the larynx itself not being taken away. The statistics and value of the operation have been much in dispute. In this country, owing to the support which it has received from authorities like Mr. Butlin (*Clin. Soc. Trs.*, vol. xxii. p. 94, and *Oper. Sur. of Mal. Dis.*, p. 196), Dr. Moure, of Bordeaux (*ibidem*, p. 1148), and Sir F. Semon (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1114), thyrotomy has been strongly advocated. By many Continental surgeons, on the other hand, this operation has been condemned, owing to its rate of mortality being much higher than has been found to be the case in this country, and also because the permanent results have proved themselves to be less favourable.

For my own part, while thyrotomy is, when all the conditions affecting these operations are taken into account, at present the one most justifiable, I feel most doubtful whether, for any cases save the very earliest, which will be few, it can be considered a sound operation, *i.e.*, one based on those principles which guide us in our attempts to exterminate malignant disease elsewhere. Amongst these the most important are to include at the time of operation not only the growth itself, but a wide margin of healthy parts around, and, further, what is sometimes forgotten in the stress of an operation, a sufficient depth of healthy tissue beneath the growth. This step, always difficult, must be

especially so with the closely subjacent cartilages.* Time alone will show whether, on sound surgical principles, the only operations before us are not partial and complete removal of the framework itself of the larynx.

Indications for Thyrotomy.—Dr. C. Jackson (*loc. supra cit.*) gives the following: (1) an intrinsic growth, that is, one limited to the ventricular bands, the ventricle, the cords, and the parts below to the limits of the larynx; (2) a limited extent of disease; (3) malignancy, or a suspicion of malignancy justifying exploratory thyrotomy; (4) no extrinsic disease, not even involvement of the arytaenoids or interarytaenoid folds; (5) no perforation of the thyroid cartilage; (6) no glandular involvement. Others limit the disease farther. Thus, Dr. Moure, of Bordeaux (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1148), holds that thyrotomy "should be reserved especially for tumours of one or other of the vocal cords. When one of the ventricular bands is affected, when there is peripheral infiltration, still more when the corresponding arytaenoid is fixed, or when there are signs of perichondritis, it is unsuitable." The same authority (*Ann. de Mal. de l'Oreille, &c.*, 1904, t. xxx. p. 407) considers that total laryngectomy is indicated in cases not limited to the cords and tending to become diffuse.

Dr. J. N. Mackenzie, of Baltimore, who holds that early extirpation of the larynx, with its lymphatics and glands, is here, as elsewhere, the safest step, considers that very small growths, distinctly circumscribed, remote from the middle line, and not of an especially malignant type, may possibly be removed with safety by extirpation of half the larynx and the lymphatics on the corresponding side (*Trans. Amer. Laryng.*, April, 1900). Speaking a few years later (*New York Med. Rec.*, Nov. 4, 1905), Dr. Mackenzie's advice was almost the same: "He did not believe that any other than the most radical operation should be undertaken in cases in which the disease was medially situated. An incomplete operation would be especially hazardous where the disease appeared as an infiltration."

The next step will be to consider the *results of thyrotomy* (1) as to the *risks of the operation*, and (2) the *probability of a reappearance of the disease*, and the amount of voice regained.

There is probably no operation about the statistics of which so much care is needed as in those for malignant disease of the larynx. The chief fallacies arise from the way in which cases are grouped together, both those in which the disease has been intrinsic and extrinsic, those where an operation appears to have been strongly indicated, and those in which it seems, owing to the condition of the patient, to have been equally unsuitable, the frequent absence of important details, and the tendency to publish only successful cases, often prematurely. If the results of one operator, a man of especial experience, are taken, another difficulty arises. Such results have only been gained as the authority passed through different stages of increasing experience.† Men who

* "The operation must be thorough. No sentimental considerations concerning the amount of vocal power to be retained by the patient must interfere with the imperative necessity of removing a sufficient area of healthy tissue around the new growth in all directions. A violation on one single part of the periphery of the new growth of this rule may frustrate the entire purpose of the operation." (Semon.)

† On this point the reader is especially referred to Prof. Gluck's results, earlier and later, candidly given (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1123).

have had very different opportunities must bear this in mind when patients or their friends, as is increasingly their wont nowadays, ask what are the risks of an operation.

And this tends to a statement with which many will disagree. Until these operations—and I refer especially to laryngectomy partial and complete—are placed upon a more satisfactory basis, they should only be performed whenever this is possible, and it usually is so, by those who combine a thorough mastery of general surgical technique and an especial training in laryngology.

Returning to the subject of statistics of the results of thyrotomy as to the risks of the operation, and the probability of a reappearance of the disease, Dr. D. B. Delavan, of New York (*Trans. Amer. Lar. Soc.*, June, 1904; *New York Med. Rec.*, Sept. 17, 1904, p. 442), puts the permanent cures as high as 44 per cent., while the death-rate can be placed at about 11 per cent. Of the patients operated on by Mr. Butlin 66.6 per cent. lived for more than three years after operation, while his death-rate was 9.5 per cent. As to the term "permanent cure," one-half and, in some instances, two-thirds of the patients reported alive and well at the end of the first year have died within three years. Statistics based upon alleged cures of less than three years' duration are therefore worthless.

Sir F. Semon's results are given (*Brit. Med. Journ.*, *loc. supra cit.*, and, with more detail, *New York Med. Rec.*, Nov. 5, 1904). He states that "my oldest successful thyrotomy dates back to thirteen years ago, and I have other patients in good health in whom the operation was performed twelve, ten, and nine years ago."

As to the amount of voice regained, Sir Felix states: "The great majority have regained a surprisingly good, although, of course, more or less husky, voice; in a few cases only have their vocal powers been reduced to a whisper."

Operation of Thyrotomy and Removal of the Diseased Parts (Fig. 250).—The points in the examination of, and the preparation of, the patient, locally and generally (p. 667), must be attended to here.

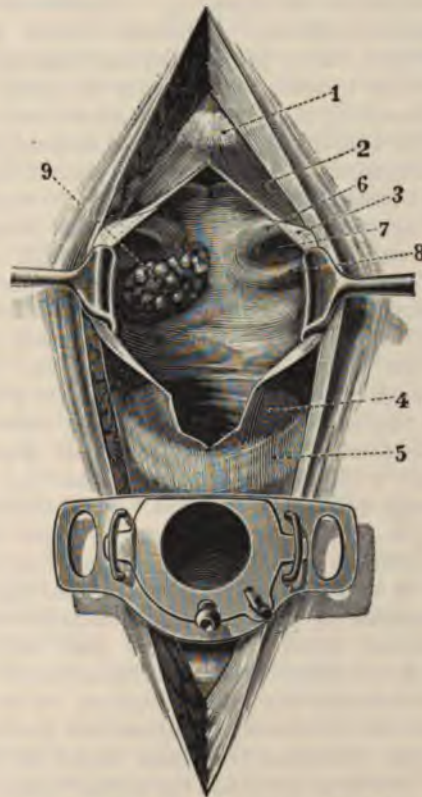
The patient, having been anæsthetised with chloroform,* is placed in the tracheotomy position, with a firm support under the shoulders. A vertical incision is made in the middle line from the hyoid bone to a point just above the sternum.† As the incision is deepened precisely in the middle line, in the upper part the thyro-hyoid membrane and angle of the thyroid should be exposed, in the lower the septum between the sterno-hyoids. This is opened, the muscles gently retracted, any superficial veins tied, and the thyroid isthmus divided, between two forceps if necessary. The angle of the thyroid cartilage is now exactly defined, the soft parts being gently peeled and pushed

* Local anæsthesia throughout (p. 650) is preferred by some. The position of Rose or Trendelenberg has also been advocated. Local anæsthesia throughout would be indicated in patients of sufficient self-control who have had bronchitis.

† This incision would appear needlessly long for a thyrotomy, but the trachea requires to be opened low down for two reasons: (1) to place the anæsthetist as much as possible out of the operator's way; (2) where advanced calcification of the thyroid cartilage is present, the cricoid and upper two rings of the trachea may require division, to enable an adequate inspection of the inside of the larynx to be made.

aside. The next step is to open the trachea low down. A trial of the position of Rose or Trendelenberg should now always be made. Hahn's sponge-cannula (footnote, p. 668) has been the one chiefly employed, but many authorities advocate an ordinary tube. This does away with any need of wasting ten or more precious minutes until the sponge has sufficiently expanded, and avoids the risk of over-distension of a slender trachea, and syncope with arrest of breathing.

FIG. 250.



Thyrotomy.—The larynx has been opened, and the halves of the thyroid cartilage separated. 1, Hyoid. 2, Thyro-hyoid membrane partially divided and separated. 3, One half of the thyroid cartilage. 4, Crico-thyroid membrane opened. 5, Cricoid. 6, Left ventricular band. 7, Ventricle of Morgagni. 8, Left vocal cord. 9, Growth upon the right vocal cord. (Moure.)

(Moure). By means of india-rubber tubing with a curved mouthpiece to fit into the cannula at one end, and a gauze-covered funnel at the other, on which the chloroform is dropped, the trachea is kept to one side. The crico-thyroid membrane is cut along the middle line, and this structure and the thyroid gland are removed with one stroke if possible by a pair of sharp, thin, slender shears, if the proc-

the use of a fine Gigli's saw (Fig. 130, p. 361) has been recommended, this instrument being passed through openings in the crico-thyroid and thyro-hyoid membranes. It will require to be kept most steadily in the middle line, or needless laceration of the mucous membrane and faulty union will result. The *alæ* of the cartilage are next pulled apart, and held so with hooks or retractors. This step is not an easy one where the cartilage is much calcified. No force whatever is allowable, or a fracture may occur. If it be impossible to obtain a complete inspection—an absolutely essential point—by the above steps, the median incision in the larynx should be continued through the cricoid and upper two rings of the trachea. Transverse division of the thyro-hyoid membrane affords additional room, but imperils the immobility of the two halves of the thyroid cartilage later on.

When the larynx is opened the entrance of mucus and blood into the air passages, especially if an ordinary tracheotomy cannula has been employed, and if the breathing is much embarrassed at this moment, must be guarded against. The anæsthetist should take care that the laryngeal reflex is present to enable the patient to cough up any fluids. In this and other operations here the anæsthetist should follow Dr. C. Jackson's advice, and allow the patient to cough up mucus occasionally. Infection of the wound must now be prevented by gauze. The chloroform should also be discontinued towards the close of the operation, so that the patient recovers consciousness by the time that the last sutures have been put in. A sterilised sponge or gauze tampon, attached to silk, may be introduced into the pharynx above, and a smaller one into the lower angle of the wound, above the cannula.

As soon as the interior of the larynx has been thoroughly exposed, and any fluids dealt with, local analgesia should be employed. The proportions vary with different operators. Prof. Gluck prefers cocaine and antipyrin (5 per cent.), and carbolic acid (1 per cent.), in distilled water, Dr. Moure uses 20 per cent. cocaine and 1 in 10,000 adrenalin. If local analgesia is employed throughout, useful information will be found in the references at p. 651. The solution employed by Mr. Barker will be found here. Any fluid used will, of course, be sterile, and applied on sterile gauze or camel's-hair brushes. After the lapse of a few minutes the actual removal of the growth is proceeded with. Here Sir F. Semon's caution that the disease will always be found to be more extensive than was shown by the laryngoscope may be repeated. He thus describes the actual removal of the growth: "The operator ought to make two semicircular or elliptical cuts, uniting in front and behind, through the whole of the soft tissues and down to the perichondrium round the diseased area, and at a distance of about half to one inch from the periphery of the growth. . . . The area to be removed having been thus circumscribed, the removal ought to take place by the growth itself being held with dressing forceps and the whole area being cut out with curved scissors, the points of which are firmly pressed against the inner aspect of the cartilage the mucous covering of which is to be removed. Unfortunately, it will be found that it is hardly ever possible to remove the whole of the growth in one piece, and, as a rule, the diseased portions will have to be removed piecemeal. The entire growth and a part of its healthy neighbourhood if necessary, including portions of cartilage, having thus been removed,

the base ought to be firmly scraped with a sharp spoon. In very rare cases only will it be found necessary to apply the galvano-cautery." Mr. Butlin "cuts out the included area right down to the cartilage, which is laid bare and finally scraped absolutely bare with Volkmann's spoon." Dr. C. Jackson condemns the use of the curette as likely to cause infection at the time of the operation and so reappearance of the disease. "The curette may be likened to the harrow that buries the seed in the soil to ensure germination." He emphasises the need of cutting far out into healthy tissue, but does not specify how to meet the chief difficulty of ensuring removal of a sufficient depth of tissue *beneath* the growth. Dr. Moure uses both curette and thermo-cautery. The bleeding can usually be checked by very fine ligatures of catgut and pressure with gauze, wrung out of very hot water or adrenalin solution. Sterilised iodoform having been applied to the surface operated upon, the alæ of the thyroid cartilage are now accurately united with salmon gut or silver wire, the sutures not entering the cavity of the larynx. The tracheotomy tube can be removed as a rule at the conclusion of the operation; in these cases where the framework of the larynx, and, thus a sufficient air-way, is left, there does not appear to be any risk of subsequent œdema of the glottis. The upper half of the skin incision is closed with sutures of gossamer salmon gut and horsehair; any sutures inserted in the lower half should not be tied for the first few days. Gauze dressings to be frequently changed as they become soiled, or, better, a boracic acid fomentation are applied.

After-treatment.—The patient is placed upon the side operated on, with the chin downwards and forwards, and only a low pillow under the head, to promote the escape of any fluids by the mouth and unclosed part of the wound. For the first forty-eight hours the operator or a skilled assistant should be at hand, so that, if needful, the tracheotomy tube may be replaced at once. Nutrient enemata are given, and, if the patient's condition require it, feeding by a tube must be resorted to. For the first twenty-four hours only sips of sterilised water or ice should be occasionally allowed by mouth. "On the following morning the first attempt is made to swallow. The patient leans far forwards, with the head down, and the dressing is taken off the wound, under which a basin is placed. Cold water is drunk out of a glass. If the experiment is successful, all the water passes into the stomach. If it is only partially successful, some escapes into the larynx. But the posture of the patient ensures that it runs through the wound, and does not pass into the air passages. As soon as water can be readily swallowed milk and other liquids may be drunk. The wound is generally closed within ten or twelve days" (Butlin).

Removal of half the Larynx (Figs. 251 to 253).—While there is reason to believe that in the hands of especially skilled operators the results here show some improvement, it is difficult to make reliable statements, as the operation has been but rarely performed, complete laryngectomy being usually employed in cases unsuitable to thyrotomy (p. 659). Here, too, many unsuccessful cases have not been published. The indications for the operation will be, briefly, cases unsuitable for thyrotomy (p. 659), viz. those in which the growth is limited to one-half of the larynx, but in which there is evidence of infiltration so deep as to render the milder operation out of the question. The

advantages that have been claimed for removal of half of the larynx over complete laryngectomy are (1) that the mortality is less, and (2) that reappearance of the disease is not more frequent; (3) that impairment of function is much less. In one of Schede's cases (*German Surg. Congr.*, April, 1884; *Lond. Med. Rec.*, 1884, p. 358) the



Epithelioma of the left cord.
(Lennox Browne.)

patient was a dentist; he could, after a while, dispense with any cannula and follow his calling, his speech not attracting notice. As a result of cicatricial contraction, a prominent fold of mucous membrane had formed, immovable, but capable of performing many of the functions of the right cord, the left moving up to it, and thus forming a rima glottidis. In the case of a well-known barrister operated on by Dr. Hahn, and brought by Dr. Semon before the Clinical Society (*Trans.*, vol. xx. p. 44; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), the patient was able for some time to fill the position of a police magistrate. After

a time the disease recurred. Mr. Butlin, writing in 1900 (*Oper. Surg. of Malig. Dis.*, p. 198), puts the mortality at 26·3 per cent., or nearly three times greater than that of thyrotomy. About three years later Prof. Gluck, of Berlin (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1123), as an instance of his improving results, said: "In one



Inner aspect of the portion removed. (Lennox Browne.)

series of thirty-five hemi-laryngectomies I had three deaths, one twenty-four days after operation of heart failure, when the wound was already healed; another, independently of the operation, of phlegmon of the right gluteal muscle; the third of pneumonia five days after operation." When unilateral laryngectomy is performed these two points must be remembered. Carcinoma may reappear in

the half left even after such a long interval as to indicate a distinct outbreak of the disease. Prof. Gluck (*loc. supra cit.*) mentioned a case in which nine years after the operation "recurrence took place in the other half of the larynx, and in the glands; after the second operation he lived over two years, and died at 76. The operations lengthened his life for eleven years." The second point is that, after removal of one-half of the framework of the larynx, cicatricial contraction may bring about a degree of stenosis which necessitates the permanent use of a tracheotomy tube.

Operation of Removal of half the Larynx.—The points which are insisted on as essential in the preliminary examination of the patient in the account of complete laryngectomy (p. 667) should be referred to, and several of the details of this operation, *e.g.*, the position of the patient, cocainisation of the nerves, apply here also. The anæsthetic should be chloroform, and the advice given at p. 662 is to be remembered. A preliminary tracheotomy is performed, as at p. 667. A vertical incision is made from the hyoid bone to the cricoid cartilage, to which transverse ones must be added if the glands are to be removed at the same time. The soft parts are raised from the larynx either *en masse* or by separation in detail according to the extent to which they may be infiltrated.

Mr. Lennox Browne (*Brit. Med. Journ.*, Feb. 5, 1887) in his case of removal of half of the larynx, one of the few reported in this country (Figs. 251, 252, 253), having exposed it by sub-perichondrial raising of the soft parts, divided the thyroid cartilage with cutting-forceps, removed the half by (a) thorough separation of the attachments to the pharynx with the raspator aided by the knife-handle and finger-nail; (b) division of the thyro-hyoid membrane as close as possible to its thyroid attachment; (c) division of the left superior horn of the thyroid cartilage at its root by cutting-pliers; (d) division in the middle line of the cricoid cartilage, in front and behind; (e) the divided half of the larynx was then separated from the first ring of the trachea, and a few nicks only were necessary to remove it entire. The very slight oozing which ensued after the removal of the diseased part was checked by a light application of the galvano-cautery, which, it was thought, would also destroy any possible fragments of diseased tissues not removed. The left aryteno-epiglottic fold was divided close to the cartilage of Wrisberg, and the thyro-hyoid membrane close to its thyroid attachment, with the view of impairing as little as possible the action of the epiglottis. The success of this plan was completely shown by the ease with which deglutition was effected three days later.

An ordinary tracheotomy cannula must be retained for some days. Whether the glands are dealt with now or later, as has been advised in the case of the tongue, must depend on the difficulties of the previous operation and the state of the patient.

Prof. Gluck's method (*loc. supra cit.*) in hemi-laryngectomy is as

FIG. 253.



Laryngoscopic view from the same patient four months after operation. (Lennox Browne.)

follows: He raises a skin flap on the affected side by a median and two transverse incisions. The larynx is exposed, split in the middle line, and the affected half loosened out. "The defect thus created is so covered with the skin flap that its edges are sewn above to the mucous membrane of the sinus pyriformis and below to the trachea, and in the middle line to the plate of the cartilage. A large tampon of iodoform gauze is introduced into the cavity of the larynx. It must press tightly against the under-surface of the skin flap, and prevent the passage of food particles into the air-passages."

Complete Laryngectomy.—The progress that has been made in operations on the larynx during the last fifteen years by the few who have had opportunities for gaining a special mastery over the needful details is nowhere shown better than by Prof. Gluck's details (*loc. supra cit.*). "In my first series of 10 cases only 2 were successful, and in 9 cases of another series I had 4 deaths. . . . My most recent results show a series of 22 complete laryngectomies with 1 death—that of a man of 70, who died on the eleventh day of iodoform poisoning. Of partial extirpations of the larynx and pharynx, generally combined with removal of infected glands, I can point to a series of 27 cases with only 1 death. This was a case in which the carotid had been tied, and death occurred from hemiplegia 5 days after the operation. . . . At present I could show you 38 living patients who have been cured by these operations. The oldest case was operated on 13 years ago. Of those already dead, a number have lived 11, 8, 6½, 5½, 4½, and 3½ years after the operation in good health, and some have died of other illnesses, not of recurrence."

Other authorities who have been candid enough to publish their results—and the small number of laryngectomies published by those who have special opportunities, and avail themselves of these opportunities, carries its own tale—have met with different success. Thus, to take one other recent series, Dr. W. Lincoln (*Trs. Amer. Lar. Soc.*, 1903, p. 54) relates the results in 7 cases operated on by Dr. G. W. Crile. In all the disease was advanced. Only 1 died from the operation, a man of 51, "who at the end of 2 weeks, when his recovery seemed assured, died in about 24 hours after the first symptom of inflammation of the vagi, characterised by marked inhibition alternating with acceleration of the heart. Of the others, 1 died 2½ years after the operation, with reappearance in the glands and pneumonia. One died 16 months after the operation from reappearance in the glands, a gland having been removed 6 months after the operation. In 1 there was no reappearance of the disease 6 years after the operation. In 1 inoperable glandular disease was present within 10 months. In 1 reappearance took place *in situ* 2½ months after the operation. In 1 glandular reappearance necessitated operation within 4 months of the operation."

This series is also of interest in its bearing upon the amount of relief gained by those who were not cured. All are stated to have been "relieved from pain, which had been in nearly all of an extreme degree. Cough disappeared in all. Dysphagia was relieved in all but two, one in which it returned in the last month of life, and one in which it was not relieved at all. Dyspnoea disappeared in all cases." The after-condition of the patients is referred to at p. 658. In estimating the value of the above conclusions, and in deciding upon an operation

where a doubt is present, the tendency to make the best of cases must be remembered; and, further, when malignant disease reappears *in situ* two to four months after an operation even by skilled hands, the question arises whether such interference, necessarily incomplete, may not have hastened this result.

Indications for Complete Laryngectomy.—Here both the local stage of the disease and the general condition of the patient have to be considered. The first has already been referred to under the headings of the operations thyrotomy and partial laryngectomy. To put the indications on this point briefly, it may be said that the complete operation is indicated in cases of malignant disease of the larynx unsuitable for thyrotomy, partial laryngectomy, or pharyngotomy, cases in which the operator has grounds for believing that he can get away all the disease, including infiltrated glands, cases, finally, in which the general condition of the patient is favourable. Here the age of the patient (not only to be recognised by years), his power of meeting and of recovery after an operation in which a peculiar form of shock will probably always be present (p. 670), the existence of any liability to bronchitis, broncho-pneumonia, asthma, his capability of assimilating food, the condition of his viscera—*e.g.*, the presence of any albuminuria, or arteriosclerosis, the history of emaciation, and, by no means least, the temperament of the patient—have all to be most carefully considered.

Operation of Complete Laryngectomy.—The first question that arises is the advisability of performing a preliminary tracheotomy. Of late years the use of a tube has been largely dispensed with during the operation. From what follows most will allow that the advantages of taking this preliminary step are considerable, and that in some cases its adoption is strongly called for. *Advantages.*—(1) It gives great relief to any laryngeal stenosis and its results on the lungs. In cases of dyspnoea it is strongly indicated. (2) While it is probable that the diminished congestion of the lungs will lessen the risk of broncho-pneumonia, it is certain that when bronchitis is already present, and other treatment does not avail, this step should be taken (Bilroth). (3) If it is intended to perform tracheotomy, and this step is employed beforehand, less time will be taken up at the operation, and no blood will enter the trachea from this source. (4) The trachea will have become adherent to the skin. In several cases, as in those mentioned by a French writer at p. 672, the necessary adhesions have not taken place. Dr. Delavan (*loc. supra cit.*) adds the following: (5) By the rest given to the larynx and adjacent parts their congestion is lessened, and it becomes easier to distinguish between diseased and healthy parts. (6) The operation being done while the patient is in a quiescent state, he is less disturbed by the sudden change in his mode of breathing, and he is in a better condition to acquire experience in the management of the tube. The *objections* brought against this preliminary step are (1) that it is not necessary, which is certainly true of many cases in the hands of experienced operators; (2) that it exposes the patient to the risk of septic infection and broncho-pneumonia. These are rare after tracheotomy in patients in fair condition; they might certainly follow in patients whose vitality is much lowered, but it is doubtful if in these the major operation is justifiable. As to the *date* of the preliminary tracheotomy, this should be at least ten

days before the laryngectomy, for the reasons already given. These outweigh the advantage claimed for performing it immediately before the main operation, viz., that the patient is thus saved two separate operations. If it be important to avoid giving an anæsthetic twice, local analgesia (p. 650) should certainly be tried. The *site* of the tracheotomy should always be low, for, if performed high up, the lower end of the excision wound will come into parts infiltrated and altered, and thus difficult to distinguish at a critical stage of the operation, and likely to lead to needless hæmorrhage. The tracheotomy may be too near to the disease, and, further, bring the anæsthetist into the way of the operator.

The preliminary preparation of the patient as regards the general state of the lungs, power of assimilating food, &c., should be of the most careful kind. Not only is the area of the operation to be sterilised, but the mouth, teeth, and nose should be disinfected as far as possible. The temperature of the operating-room and every precaution for preventing shock should be attended to. An electric head-light will be found very useful. The means for administering oxygen should be at hand. Chloroform is administered with the precautions already detailed at p. 662. If a tracheotomy has been performed it is given by the tracheotomy tube. If no tracheotomy has been employed, the anæsthetic is given as long as possible in the ordinary way, and later on when the trachea is severed by tubing fitting the inner tube of the tracheotomy cannula exactly. Whether the operation is performed from above downwards or *vice versâ*, the Trendelenberg or Rose's position should be tried as soon as the larynx and trachea are well exposed. Removal from above downwards, by leaving the division of the trachea to the last, is held by some to avoid the risk of the escape of blood and lotions into the trachea, and thus to avoid any need of using expensive and sometimes unreliable* tampon cannulæ. Sterilised sponges or gauze tampons attached to silk must be at hand to be placed in the trachea above the tracheotomy cannula and in the pharynx. If no tracheotomy is performed either some time previously or immediately before the operation, the median incision being made, the trachea is usually first isolated and divided, and then a large tube inserted.

* There is a tendency nowadays to dispense with the tampon cannulæ, different kinds of which have been introduced in order to prevent fluids entering the trachea and air-passages. Hahn's tube consists of an inner and an outer tube, the inner of which is the longer, projecting about an inch and a half in front of the shield, so as to render the entrance of blood very unlikely. In order to prevent this projection inconveniencing the operator, it is made to bend down parallel with the trachea before it stands out at a right angle with the neck. The outer tube is partly covered with a layer of compressed sponge, previously soaked in iodoform and ether (1 in 7). The sponge is fastened on by sutures and by silk tied round both its upper and lower ends. About ten to twenty minutes after the introduction of the tube the sponge swells up from the absorption of moisture, and the entrance of liquids into the trachea is thus prevented. While the delay is an objection (p. 661), this arrangement of sponge holds the tube more steadily in position than the india-rubber bag of Trendelenberg's tampon, which is liable to become slippery, may burst during the operation, may allow the air to escape and thus become useless, while, in common with all cannulæ, its introduction may be followed by a stoppage of the breathing. If Hahn's tube is employed, it will be found somewhat difficult to adapt the right amount of sponge exactly to the lumen of the trachea. If an ordinary tracheotomy tube be employed, it must fit snugly, without any undue force or pressure (p. 661). A jacket of sterilised tubing or gauze may ensure this.

The plan of the operation must be carried out according to the conditions found when the interior of the larynx has been thoroughly exposed. I shall suppose at first that the disease is too diffuse to allow of a unilateral laryngectomy, but that it has not infiltrated the framework of the larynx deeply. If the operation be begun from above an incision is first made from the lower border of the hyoid bone, exactly in the middle line, vertically down to the level of the first or second ring of the trachea, and a second at right angles to the first, either at the level of the hyoid bone or below, in either case passing outwards to the sterno-mastoids. The lower transverse incisions may give more room and prevent any need of prolonging the longitudinal wound down to the tracheotomy incision if this preliminary operation has been performed, a step which is difficult to avoid in short necks (v. Bergmann).^{*} The vertical incision should go down to the thyroid and cricoid cartilages and trachea, the thyroid and cricoid cartilages being carefully severed in the middle line with stout scissors or cutting-forceps, the two halves separated with retractors, and the interior examined. The soft parts over the thyroid and cricoid are then raised *en masse* by inserting a blunt dissector or raspatory so close to the cartilages that the perichondrium itself is lifted up, with its relation to the soft parts over it undisturbed. This separation is carried back as far as the middle of the junction of the larynx and pharynx. The thyroid isthmus is drawn downwards or, better, divided between two ligatures; the larynx is pulled to either side with sharp hooks, and the attachments of the inferior and lower part of middle constrictors and stylopharyngeus divided. All vessels, especially the superior laryngeal and superior thyroids, must be carefully secured. The trachea, separated from the œsophagus by the careful use of a blunt dissector, a curved periosteal elevator, or snips of curved blunt-pointed scissors, is cut through between the first and second rings. If no tracheotomy has been performed, two stout sutures of silk are passed through the whole thickness of the trachea, one on either side; and by these the tracheal stump is drawn downwards and forwards and secured by most careful suturing in the lower angle of the wound, or in a separate incision made for this purpose just above the sternum (Gluck, *vide infra*). Two precautions are needed here. In freeing the trachea sufficiently to allow of its being brought downwards and forwards so as to diminish the risk of entrance of fluids, care must be taken not to bare it too much, and thus cut off its blood supply. The sutures employed to keep it firmly and snugly in position should be of reliable cat-gut or kangaroo tendon. If of salmon gut they must be left long, to facilitate their removal. Two stout silk sutures are now passed through the upper cut end of the trachea, and by traction on these the larynx is carefully separated from the œsophagus and pharynx from below upwards. The excision is completed by division of the thyro-hyoid ligament and the mucous membrane at the entrance of the larynx. The epiglottis and its folds should be left intact, if possible.

^{*} The operator can use a T-shaped incision, a vertical one with transverse cuts at either end, or a flap with its base upwards. This last method, used by Durante and Crile, is referred to below (p. 672). It is especially adapted to those cases where it is not possible to suture securely the pharynx and œsophagus. Other flap methods are given by Prof. Gluck (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1119).

The above method of working very close to the cartilages with a blunt instrument only has the conspicuous advantages of disturbing but little the soft parts and of causing but trifling hæmorrhage.*

Where the parts do not admit of the above step, for instance, where the cartilages are infiltrated or where the parts outside—*e.g.*, glands—are found involved, and the operator decides to go on with the operation (p. 657), much severer steps are necessary. The larynx must now be looked upon as a malignant growth elsewhere. Flaps of skin and fascia are reflected, and the larynx exposed as freely as possible. Any enlarged glands now seen should be removed, and superficial vessels secured. The sterno-hyoids, sterno-thyroids, and thyro-hyoids are next severed near the thyroid cartilage, and the lateral lobes of the thyroid gland carefully separated in the same way (*vide infra*), ligatures being tied at their junction with the isthmus, if needful. The soft parts at the sides which contain the large vessels, &c., are now carefully retracted, and the larynx being drawn first to one side and then to the other, the inferior, lower part of middle constrictor and stylo-pharyngeus muscles are divided very close to their attachments to the cricoid and thyroid cartilages. The introduction of an œsophagus bougie may facilitate this step, and save needless "button-holing," now and in the separation of the œsophagus from the trachea. The superior laryngeal vessels are secured and divided as they enter the thyro-hyoid membrane. To produce anæsthesia of the nerves which may carry inhibitory cardiac impulses, Dr. Crile injected cocaine into the superior laryngeal nerve before dividing it in two of his cases published by Dr. Lincoln (*loc. supra cit.*). Information on this point has been given at p. 226. Further experience is needed before we can rely on this step for preventing the serious respiratory and cardiac disturbances which have followed during the raising up and dissection out of the larynx, and also for diminishing the shock afterwards.

The larynx is next severed from the trachea at the second ring, the stump of the trachea being dealt with in the manner already given. The detachment of the larynx from the œsophagus is then carried out from below upwards, with the precautions given above not to button-hole it. As the dissection is carried upwards to the laryngo-pharyngeal junction the anterior and lateral walls of the pharynx will require partial removal in these more advanced cases. At this stage the following details given by Mr. Harvey, surgeon to the Hospital for Diseases of the Throat in Golden Square, and one of the few English surgeons who, having had opportunities for performing laryngectomy, has published cases, will be found useful (*Lancet*, Sept. 21, 1901). After the stump of the trachea has been stitched to the skin "the next step will be to dissect off the upper portion of the trachea from the œsophagus and the muscles from the lateral surface of the cricoid. The inferior corner of the thyroid is next bared by detaching and reflecting the crico-thyroid and inferior constrictor muscles. The

* In thus raising the soft parts, by keeping close to the cartilages of the larynx, care should be taken not to separate needlessly the soft parts from the trachea. Some of these—*e.g.*, the lateral masses of the thyroid gland, which are now also detached with a blunt dissector—are useful in preventing descent of the trachea. Sloughing of the tracheal stump and failure of union to the skin has followed in several cases (pp. 672 and 673).

muscles and perichondrium in front of the thyroid will now be separated and reflected as far back as the superior cornu, which latter will next be freed by dividing the periosteum on its surface, and pushing it along with the lateral wall of the pharynx and the loose areolar tissue backwards until the posterior lateral border of the cricoid is reached. The outer two-thirds of the lateral portion of the thyro-hyoid ligament will then be divided transversely and cautiously at the junction of its middle and upper thirds; and when the adjacent mucous membrane is reached this must be picked up with forceps and divided, whereby the upper portion of the epiglottis can be seized and drawn forwards. The anterior wall of the pharynx is thus opened, and by pulling the epiglottis strongly forwards, and with it the whole larynx, the knife can be placed on the posterior surface of the cricoid, and by cutting downwards the anterior wall of the œsophagus will be opened. Care must be taken at this point to limit the cut to the parts which are covered in front by the posterior surface of the cricoid; if this is not done, the lateral wall of the pharynx and œsophagus will be unnecessarily encroached upon, thus rendering it difficult to approximate their edges. The whole larynx is thus completely detached, and the defect in the pharyngeal mucous membrane must now be made good by inserting sutures quite close to the cut edges, and so preventing in-turning of the epithelial surfaces. The sewing up must be watertight, with fine catgut sutures, so as to form a Y-shaped stitched line; then a row of Lembert's sutures must be added, transfixing the muscular and cellular coats of the œsophagus and pharynx. The third layer unites the stumps of the pharyngeal constrictors, and the fourth brings together the divided sterno-hyoid and thyro-hyoid muscles."

If closure of the pharynx be found impossible its cut edges must be united by numerous sutures of sterilised catgut to the soft parts about the base of the tongue and hyoid bone, secure union here, as in the case of the sutured stump of the trachea, being of the utmost importance to prevent infection of the wound by fluids from the mouth.

All hæmorrhage having been carefully arrested, drainage is supplied by securely packing any pockets in the wound with strips of iodoform gauze, which are led out above and below. The wound is sewn together over these strips, and a boracic acid fomentation applied. A soft tube may be passed by the nose into the œsophagus at the time of the operation. If this occasion retching and coughing it must be passed as required.

As to the removal of glands, Prof. Gluck carries this out at the time of the laryngectomy. By most, considering the severity of the first operation and the thoroughness and time required if epitheliomatous glands in the neck are to be attacked to any purpose (p. 604), this proceeding will be deferred to a later stage.

The **after-treatment** is considered at p. 674.

Numerous modifications have been introduced in the technique of laryngectomy with a view especially of diminishing the risk of broncho-pneumonia.

Gluck (*Brit. Med. Journ.*, *loc. supra cit.*) does not perform a preliminary tracheotomy. After the usual incision, exposure of the sides of the larynx, division of the muscles, separation of the thyroid gland, and ligature of the superior laryngeal artery, the patient is placed so that the head hangs over the end of the table, the thyro-hyoid membrane is

divided, and the pharynx plugged with gauze, so as to prevent the descent of saliva. The larynx is then drawn steadily forward as it is separated from the pharynx and œsophagus until the lower margin of the cricoid is reached, when the whole larynx can be drawn out of the wound. A transverse incision is now made above the episternal notch, and from this the skin is loosened upwards into the upper wound so as to leave a bridge of skin 4 to 5 cms. wide. Two strong threads are then passed through the trachea, the larynx is cut away close above the threads, and the stump of the trachea drawn by the threads under the bridge of skin into the button-hole-like opening above the episternal notch. It is here fixed by sewing its edges all round to the edges of the skin wound. The opening in the pharynx is closed by one or more rows of sutures, and all the different pockets of the wound and the mouth are packed tightly with iodoform gauze. The skin is sewn together over this packing. The patient is fed by an india-rubber tube passed through the nose.

The advantage of thus separating the opening in the trachea by a considerable distance from the wound is obvious, but nothing is said as to the difficulties which are apparently certain to arise in the administration of an anæsthetic if the above technique is followed. It is not stated that local analgesia is employed.

Le Bec (*Ann. de Mal. de l'Oreille, &c.*, 1905, t. xxxi. p. 375) has followed Chiari in dividing laryngectomy into two stages. In the first, the trachea is detached from the larynx and sutured to the skin. In the second, performed eight to fourteen days later, the larynx is removed. He claims that by this method shock is diminished, and the risk of broncho-pneumonia greatly lessened. The trachea is exposed by an incision extending from below the cricoid to the sternum and isolated laterally, with care to preserve sufficient cellular tissue to ensure its nutrition. The tube, severed below the cricoid, is drawn downwards and forwards, and fixed to the skin by sutures which take up the trachea between its second and third rings. A tracheotomy tube is placed in the opening, and the wound closed with drainage. At the second operation the larynx is removed by the steps already fully given (p. 669). * Dr. Le Bec's patient recovered.

Dr. Canzard (*loc. supra cit.*, pt. ii. p. 165) states that in the above case, after the removal of the silk sutures by which the stump of the trachea had been united to the skin, union failed to take place, but as this wound, by the adoption of the two-stage method, had become shut off from that of the major operation, re-insertion of a few sutures was sufficient. He mentions another case operated upon at one time in which the patient was a very restless one. Sloughing of the divided trachea was followed by a fatal result two weeks after the laryngectomy.

Dr. Durante, the well-known surgeon at Rome, in order to prevent the risk of lung troubles, makes use of a flap intended to close the pharyngo-œsophageal opening so that mucus and saliva shall be conveyed directly into the œsophagus, and the large wound remaining after laryngectomy be reduced to a minimum. An account of his operation, with excellent photographs, is given in a brief paper in the *International Clinics*, 1905, p. 122. A large horse-shoe flap consisting of skin and superficial fascia is raised by an incision which, starting at the right angle of the mandible, descends along the sternomastoid to a point 3 cms. above the episternal notch; thence, curving across to the left side, it ascends along the sternomastoid to end at the left angle of the jaw. The flap is raised as high as the hyoid bone, the larynx exposed, and, after the performance of a low tracheotomy, removed by the steps already given. When all bleeding has been arrested the flap is sutured "from above downwards to the edges of the pharyngo-œsophageal mucous membrane, in such a manner that the rete Malpighii comes into more or less direct contact with the cut edge of the mucous and submucous coats of the pharynx and œsophagus. The lower end of the flap remains behind the tracheal stump, and is fixed to it with stitches so as to render it immobile. The whole bleeding surface is thus reduced to two lateral clefts, which should be packed with gauze."

Both the patients on whom Dr. Durante employed this method recovered rapidly, one being able to swallow milk and water on the second day after the operation. The first died two months later with infiltration of the glands and hæmorrhage from the carotid artery. In the second an enlarged gland and "all the objective evidence of carcinomatous cachexia" appeared eight months after the operation. In this case it is to be noted that at the time of the laryngectomy "the carcinoma was rather circumscribed, and there was no evidence of metastasis."

Föderl endeavours to meet the dangers of pneumonia by restoring the lumen of the air tube. On the cadaver, and in one case of tracheal stenosis in which he operated with striking success, he found that the severed trachea was sufficiently mobile to admit of its being pulled up and united to the parts left about the hyoid bone.

A preliminary tracheotomy is performed. The larynx is removed by the steps already given, it being essential to retain the epiglottis and aryæno-epiglottidean folds. All hæmorrhage having been completely arrested, the mucous membrane on the posterior aspect of the severed trachea or the cricoid cartilage, according to the site of division, is united to the aryæno-epiglottidean folds. Anteriorly some of the sutures taking up the air tube below pass around the hyoid bone, beneath the mucous membrane, and also the base of the epiglottis, in order to prevent retraction. The sutures, mostly of sterilised cat-gut, are introduced from behind forwards, and none are tied until all are inserted. Tension on the deep sutures is relieved by drawing together the soft part with silk sutures where this is practicable. Two iodoform drains are employed, and the skin wound is sutured. Immobilisation of the head was not found necessary.

In a case in which v. Hippel tried this method the upper end of the trachea sloughed from ulceration and infection; the patient ultimately recovered.

Operation in Cases of Extrinsic Malignant Disease involving the Pharynx extensively.—If, after careful consideration of the case, the vitality of the patient, and his decision justify resort to such an operation, the following are the lines on which Prof. Gluck (*loc. supra cit.*) carried it out:—

"In order to extirpate the larynx with the pharynx, I expose first the whole larynx, and place the patient so that the head hangs down over the edge of the table. I then divide the membrane between the hyoid bone and the larynx, and draw the larynx forward in front of the wound. The inner surface of the pharynx is now well seen, and one can divide without difficulty the side walls and anterior edge of the pharynx straight through above the tumour. Next I push forward into the loose tissues between the pharynx and œsophagus and the vertebral column, and detach the pharynx from the vertebral column till I have reached the lower pole of the tumour. I cut the œsophagus straight off, as far as possible below the tumour, and then loosen the œsophagus from the trachea for a short distance. The larynx is then divided from the trachea as in laryngectomy, and the tracheal stump pulled under the skin-bridge and into the button-hole above the episternal notch, where it is firmly stitched. The wound is closed towards the mouth by sewing the pharynx walls, or, if one has cut off the pharynx very high, by packing with iodoform gauze. An india-rubber tube is placed in the œsophagus." Prof. Gluck draws flaps of skin together by sutures over gauze; other surgeons leave the wound open.

The edges of this gradually become inverted, and the granulating surface slowly covered by epithelium until a deep furrow leads from the pharynx above to the œsophagus below. Narath (*Arch. f. Klin. Chir.*, Bd. lv. S. 840) advises the closure of this by a plastic operation by double flaps, as in Duplay's operation for hypospadias (*q.v.*), some months later to convert the above furrow into a tube. Two flaps are marked out and dissected upon either side of the furrow. They are then turned inwards and sutured in the middle line. They should not contain any hair follicles. Over the raw surface of these, if the tissues of the neck are sufficiently lax, two other flaps are guided inwards. Further operations may be needed for fistule dating to failure of complete union.

Trans-hyoid Pharyngotomy.—This operation is indicated in a few cases of extrinsic malignant disease, *e.g.*, those where the mischief originates in the epiglottis, aryæno-epiglottidean folds, and is limited to these parts.

The operation is described at p. 618.

Dr. Moure, of Bordeaux (*Brit. Med. Journ.*, Oct. 31, 1903, p. 1148) does not introduce a tube into the trachea until the hyoid bone has been split in the middle line and the base of the tongue is reached. "The tube is introduced under superficial anaesthesia, so that the patient may cough up any blood that may find its way into the air passages; this

being accomplished, the anesthesia is deepened, and the base of the tongue divided by a vertical mesial incision. By drawing the two halves apart the epiglottis is exposed; it is then drawn forwards and removed. An energetic application of the curette and the thermo-cautery completes the operation. The two halves of the tongue are then sutured with catgut; the halves of the hyoid are held together by stitching the muscles above it and below."

In one of Dr. Moure's patients the following deformity developed. The glottis became elongated and reduced to a mere slit, no longer capable of taking the usual triangular form. Aspiration of the aryteno-epiglottidean folds interfered with respiration so much that it was necessary to introduce a tracheotomy tube, but, after a time, the glottis gradually regained its normal form almost completely, and the tube was removed.

Palliative Tracheotomy.—This may be indicated in cases unsuited to attempts at extirpation, or where a patient declines these, with the object of retarding the rate of the disease and preventing or relieving dyspnoea. The chief guides are the general condition and vitality of the patient (p. 667) and the extent of the disease, *e.g.*, to the pharynx widely, epiglottis, and back of tongue, with evidence of infiltration and involvement of glands. While the relief given at first may be decided, the closing scene is often distressing, as when ulceration of the soft parts takes place, or when, owing to the downward extension of the growth, the tracheotomy tube becomes a source of constant irritation and distress, though absolutely necessary for respiration. In such cases, where the suffocative cough and dyspnoea cannot be relieved by other means, the question of laryngectomy may arise after a palliative tracheotomy has been performed, as in a case which Mr. H. Morris brought before the Clinical Society (*Trs.*, vol. xx.; *Brit. Med. Journ.*, 1886, vol. ii. p. 975). The patient, æt. 59, sank on the eighth day.

After-treatment.—As the best of all positions, the prone, is rarely endured, a trial should be made of Prof. Keen's plan of keeping the patient for the first day or two in the Trendelenberg position, by putting a chair under the foot of the bed (*Ann. of Surg.*, 1899, vol. xxx. p. 1). Discharges must be prevented from entering the trachea by stitching some gauze, changed daily, round the tube. The inspired air should be charged with antiseptic vapour. Nourishment must be supplied for the first week, or until the deeper part of the wound is consolidated, by a soft tube passed either by the nose or mouth, for which the patient should be prepared before the operation. If the repairing sutures in the pharynx give way, the use of the tube will be more prolonged. Feeding, save for the first few hours, by enemata alone is not reliable, considering the debilitated condition of these patients and the profound shock which may accompany this most serious operation. When the wound is consolidated, the patient should be encouraged to take some semi-solid food by the mouth, liquid food thus taken having always a greater tendency to get into the wound. Thirst must be met by ice in the mouth and sips of sterile water. The temperature of the room should be from 65° to 70°. No morphia is to be given, if possible. Secretions and coughing may be diminished by adopting a suggestion of Dr. Delavan (*loc. supra cit.*) and giving small doses of belladonna.

After the second month the question of an artificial larynx will arise. This consists, in the main, of three parts, a lower or tracheal and an upper or laryngeal tube, which lies in the pharynx, and contains some

form of vibrator or reed. Most of them have not been successes. Prof. Gluck's appears to be the best; it is distinguished by its simplicity and the fact that the upper tube ends behind the uvula, or is brought out, curved, at the angle of the mouth. Some American surgeons report that this gives good phonetic results, that it is easily worn and adjusted, and that the vibrator is readily cleaned and replaced.* As a rule, the artificial larynx has been found to be liable to the following objections. Irritation is produced by pressure at a spot where all irritation is especially to be avoided; the vocal vibrator is liable to produce a sound, often noticeable and whistling, with every respiration. It often becomes obstructed with mucus and saliva, and prolonged attempts at talking with such apparatus prove exhausting from difficulty in breathing. For this reason the artificial larynx has often been abandoned, the patients contenting themselves with a whispered voice, and the use of a slate or writing-pad.

Some American surgeons have found benefit from placing the patient under "an experienced teacher, from whom he acquires the art of communication by audible sounds generated entirely above the region of the larynx" (Delavan).

Dangers and Causes of Death.—These will have been gathered from the details already given. It may be well to recapitulate the chief ones:—(1) Shock. (2) Exhaustion. (3) Broncho-pneumonia, abscess and gangrene of the lung, and empyema. Dr. Cohen, of Philadelphia (*Inter. Encycl. Surg.*, vol. v. p. 776), considers that the first two weeks constitute the chief period of danger from lung complications, and that if the patient survive this date, he is tolerably secure up to the fourth month, when the period of the risk of reappearance begins. (4) Infective conditions, *e.g.*, septicæmia, toxæmia, cellulitis, mediastinitis. (5) Iodoform poisoning. (6) Secondary hæmorrhage. This occurred in Surgeon-Major Macleod's case (footnote p. 657) on the fifth day, causing death rapidly. The course of the bleeding could not be determined. The disease was extensive. (7) Displacement of the tracheotomy-tube. (8) In some cases a rapidly fatal result has followed when all has seemed to be doing well (p. 666), perhaps from influences conveyed along the cardiac fibres of the vagus, from changes in the cut superior laryngeal nerves, or in branches between the sympathetic and vagus, of which very little is, at present, known. (9) Stenosis from cicatricial contraction. (10) Other risks inseparable from operations in which an attempt is made to extirpate infiltrated and adherent epitheliomatous glands in the neck.

Finally, other risks inseparable from laryngectomy in some patients must be remembered, *viz.*, the visceral and vascular changes usually present, and the mental misery from the isolation, the discomfort, and, at times, the degree of inanition daily from the escape of liquids where the pharynx has been extensively extirpated, and where the repairing suture lines have not held their place, or where a plastic operation has failed.

* The apparatus is briefly described and figured by Dr. W. I. Terry (*Ann. of Surg.*, 1904, vol. i. p. 968). In this patient, æt. 42, complete laryngectomy was performed after the failure of a repeated thyrotomy. The last result given is that of the performance of the laryngectomy.

I have not thought it worth while to give any details of those very rare cases in which the larynx has been removed for other causes than carcinoma and sarcoma.

In Sir P. Heron Watson's case quoted by Dr. Foulis (*Trs. Intern. Med. Cong.*, 1881, vol. iii. p. 251), the larynx was removed on account of the trouble that persisted in a case of tertiary syphilis after tracheotomy. Rubio, of Madrid, removed the larynx for necrosis. Dr. Foulis (*loc. supra cit.*, p. 258) mentioned a case of Dr. Bircher in which the larynx was removed with part of the œsophagus for reappearance of carcinoma of the thyroid. Prof. Caselli (*ibidem*, p. 262) stated that he had performed partial laryngectomy for an enormous myxofibrochondroma of the hyoid and larynx. All these four patients sank at varying periods after the operation. It is fair to remember the exhaustion present in each case, and the date of the laryngectomies.

CHAPTER XIII.

OPERATIONS ON THE THYROID GLAND.

REMOVAL OF THE THYROID GLAND,* PARTIAL AND COMPLETE.

Indications.

1. Failure of previous treatment and increase of the bronchocele, leading to—2. Dyspnœa sufficiently constant to prevent the patient from following any active employment, or one of a sedentary kind which involves stooping of the neck and head. 3. The existence of tracheal stridor, especially if accompanied by enlargement of the isthmus or extension of the lobes laterally or downwards (see p. 682).

I have met with several excellent cases of lateral compression of the trachea by the thyroid. The first patient was sent to me by Dr. Fraser, of Romford, many years ago. Here the marked tracheal stridor, breathlessness on any exertion, but only weakened voice, were accounted for by the windpipe being in this case a well-defined instance of "the scabbard trachea," the tube being bluntly keel-like in front, with concave surfaces from the strap-like pressure of the enlarged isthmus. The sides of the thyroid cartilage showed, from the same cause, very marked concavities. A good recovery followed removal of the isthmus and one lateral lobe, and the patient, instead of being a nervous, exacting invalid at home, was able to take up work as a nurse in one of the London hospitals.

Uni- or bilateral compression (the scabbard trachea) is certainly the most constant form of narrowing. The circular form is shown in Fig. 253. I have never been able to satisfy myself that any softening of the trachea existed in any of my cases in which stridor was present.

4. Attacks of sudden, suffocating dyspnœa.

It is not yet sufficiently recognised by the profession that a bronchocele, whether it be moderate in size or large, may from some sudden engorgement or rupture of its vessels cause urgent and fatal dyspnœa. A first attack may here only herald in the end.†

The following may be quoted to prove that the above danger is well founded:—

Dr. Hurry (*Lancet*, March 19, 1887) relates the case of a girl, aged 13, the subject of a moderate goitre. Dyspnœa was first complained of on Nov. 3. On Nov. 7, dyspnœa

* A distinction must always be made in these operations between removal of parts of the thyroid itself and that of encapsulated adenomata in it (p. 695), however large.

† Thus, in one case, a woman with a bronchocele which, so far as was known, had not given previous trouble, waking out of sleep suddenly, was terrified by seeing her little child playing about the room with a piece of wood taken alight from the fire. Most urgent dyspnœa set in, and, before surgical relief could be given, death took place from suffocation. In another case, that of a woman the subject of a bronchocele, and straining violently in the throes of parturition, similar dyspnœa set in as rapidly, and with the same result.

was urgent, and tracheotomy was called for. The operation gave very little relief, and death followed an hour and a half later. The necropsy showed a moderately large goitre, the two lobes of which entirely encircled the trachea and reduced the lumen to a narrow slit, to which the tracheotomy wound did not quite reach.

Dr. Hurry gives the following ingenious explanation of the insidiousness and urgency of the dyspnoea in these cases : Owing to the slowly progressive enlargement of the thyroid, the dyspnoea at first is slight ; one day some extra exertion calls into play the additional muscles of respiration—*e.g.*, sterno-mastoid, sterno-thyroid, sterno-hyoid,—which, pressing on the trachea, still further close its lumen, already narrowed by the slowly progressive growth. This brings about additional dyspnoea, and so induces more vigorous contraction of the inspiratory muscles, and so further closure of the trachea, and finally fatal dyspnoea.

Dr. Dewes (*Brit. Med. Journ.*, Jan. 18, 1879, p. 84) records the case of a patient who was found by the Coventry police apparently dying of suffocation. On his admission into the hospital a large bronchocele was found, and a free median incision was made by Mr. Read down to the tumour. The breathing at once improved and soon became natural, the tumour decreased in size, and all went well till the evening of the seventh day, when the dyspnoea suddenly returned, the tumour again enlarging, and the patient dying in two or three minutes. It was found at the necropsy that in the last agony the posterior part of the tumour had broken down, giving rise to a large extravasation of venous blood, pressing on the respiratory nerves. "The only part of the trachea at all approachable was under the manubrium sterni, where it was covered by the innominate artery."

I wish to draw attention to another fact, that extravasation may take place suddenly into a bronchocele, and thus produce urgent dyspnoea.

In 1885 a woman, aged 44, came under my care with enlargement of the thyroid, the right half having been increasing in size for some years, but her chief trouble was due to a swelling, in the position of the isthmus, of the size of a small orange. This had existed about a year, but had suddenly increased in size, while the patient was singing, six months before. The patient's voice, originally an alto, was now hoarse and gruff, and of very small compass. Removal of the isthmus showed that this was occupied by a cyst, containing in the centre firm coagulum. Two years later, when the patient was last seen, the right lobe had subsided to the size of its fellow, but the voice was still deep and somewhat hoarse.

Occasionally it may be an accessory thyroid, not the main gland itself, which is the cause of the dyspnoea, and perhaps of death. Such a case is recorded and an illustration given by Mr. Bland Sutton (*Lancet*, vol. i. 1895, p. 462).

A man, æt. 36, was found lying on his back in a street adjoining the Middlesex Hospital, apparently in a fit. When brought in by the police he was dead. At the necropsy an accessory thyroid embedded in a thick fibrous capsule was found firmly fixed to the trachea in the neighbourhood of the fourth to the ninth cartilages. Though only about the size of a dove's egg, it had severely compressed the trachea and caused the fatal dyspnoea.

It will be well at this point to advise, in those cases where treatment is suddenly and urgently demanded for goîtres threatening suffocation :

(1) If, as is very possible, the surgeon is short-handed,* and no adequate preparations have been made, it will be wiser to slit the deep

* The sudden onset of these most serious cases emphasises my opinion that treatment here to be successful should be *preventive*. Patients with the slightest degree of tracheal stridor and dyspnoea should be warned of the risk of suffocation, and operated on by removal of one lobe, before there is time for the last, and perhaps fatal, attack to occur.

cervical fascia, especially in cases where this is well developed, freely in the middle line, so as to allow the enlarged thyroid to bulge forward and away from the narrowed trachea. This, combined perhaps with venæsection if much lividity be present, will very likely suffice for a time. But Mr. Read's case (*vide supra*), in which this step was adopted, shows that, by itself, it will not be enough; and it exposes the patient to serious risks of infection (p. 704). At the same time, if preparations can be made, or as soon after as is possible, the isthmus and one lobe of the thyroid should be removed.*

(2) If slitting up the deep cervical fascia does not suffice, the treatment lies between tracheotomy (if it be possible) or removal of the isthmus and one-half of the thyroid if the patient's condition on administration of the anæsthetic † (A.C.E. or chloroform) admit of this operation. Where slitting up of the fascia is not sufficient, and where, owing to the urgency of the case, the fact that the needful preparations cannot be made, or the increased dyspnoea caused by the anæsthetic, removal of part of the gland is out of the question, tracheotomy is the only step left. There are marked objections to it. (α) It is often beset with great difficulties. Thus, if the surgeon open the trachea above the isthmus he is unlikely to have a suitable cannula at hand. In such cases a large-sized gum-elastic catheter, with the end cut off, as in Mr. Morton's case given below, or a full-sized Durham's cannula, with drainage-tube attached (p. 705), may suffice (unless there is sub-sternal enlargement of the thyroid) until a special cannula, such as that shown in Fig. 255, can be provided. (β) On the other hand, opening the trachea below the obstruction may be impossible, as in cases where a huge isthmus reaches from just below the cricoid cartilage to the manubrium sterni. Dividing such an isthmus and then performing tracheotomy may be accompanied by severe hæmorrhage and infective pneumonia. (γ) In cases where it is possible to open the trachea below the isthmus the difficulties of a low tracheotomy (p. 630) will be intensified, and the risks of encountering large vessels, such as the innominate artery, must be remembered, while that of subsequent pneumonia is much increased. On the whole, a high tracheotomy, and the use at first of a gum-elastic catheter, is the less risky procedure to adopt. König's cannula (Fig. 255), if at hand, would

FIG. 254.



This figure shows one way in which the trachea may be narrowed by a bronchocele, and how great the stenosis may be. If in addition there were pressure on the opposite recurrent laryngeal nerve, or if an anæsthetic had to be given, it is obvious how easily a fatal result might follow. (Esmarch and Kowalzig.)

* The cases given below show that division or removal of the isthmus by itself cannot be relied upon.

† As these cases occur usually in adults, a trial of local analgesia (p. 650) is indicated,

be very useful. Where the goitre, which is causing suffocation, is unilateral, the compression is due to a cyst or an adenoma, not to an ordinary goitre. In the one case the cyst (probably containing blood, as in my case, p. 678) must be removed or drained (as in Mr. Bowlby's case, p. 681); in the other the surgeon should remove the enlarged lateral lobe if he cannot easily find and shell out the adenoma (p. 695). The following case by Mr. C. A. Morton (*Bristol Med.-Chir. Journ.*, Sept. 1896) of sudden dyspnoea in goitre treated by tracheotomy and removal of the isthmus is most instructive:

A man, æt. 20, was admitted with tracheal stridor, due to enlargement of the thyroid of five years' duration, increasing rapidly during the previous fortnight. The isthmus covered the front of the trachea from the cricoid cartilage to the episternal notch. The

FIG. 255.



König's flexible cannula for tracheotomy in cases of goitre displacing or narrowing the trachea. (Esmarch and Kowalzig.)

The trachea was of the typical keel-like shape from the cricoid cartilage to well below the episternal notch. Mr. Morton separated it freely from the lateral lobes with a blunt instrument, and divided all the fascia over it. So great was the general enlargement of the thyroid that the cut surfaces met over the trachea, although an inch of the isthmus had been removed. The hæmorrhage during the operation was never serious. A large-sized catheter was left in the trachea. For many days after the operation the patient was subject to a feeling of suffocation whenever the catheter was removed, so that it had to be replaced. About a fortnight after the operation it was found possible to leave it out for nearly a week, when the breathing became laboured and the instrument had to be replaced. It was finally dispensed with a month after the operation. Three days after the operation, pneumonia of the lower two-thirds of the right lung ensued, the signs of consolidation persisting for several weeks. Diminution of the thyroid, slow at first, was later on very marked, there being, two months after the operation, very little

enlargement left in either lobe. The wound, infected by that for laryngotomy, suppurated and healed by granulation. The patient was discharged in six weeks, and six months after the operation he could run upstairs without any dyspnoea; his breathing never again became laboured or stridulous. As is often the case after thyroidectomy in severe cases, the voice remained hoarse a year later. The larynx was normal. Perhaps, as suggested by Mr. Morton, the hoarseness was in this case due to interference with the action of the crico-thyroid muscle owing to the cicatrix in the crico-thyroid membrane.

The following cases show, I think, conclusively that, where removal of the isthmus does not relieve the dyspnoea, the whole of one lateral lobe should be removed. Taking this step will probably avert the need of tracheotomy, which renders infection of the wound highly probable, and the onset of that most perilous complication, pneumonia, so very likely. No doubt, in some of these cases—Mr. Morton thinks in many—the dyspnoea will be too rapidly fatal for excision of one lobe to be undertaken for its relief. Dr. Lediard's case shows, however, what can be effected in severe cases.

The first was published by Mr. J. Marsh (*Birmingham Med.-Chir. Rev.*, 1894, vol. xxxvi. p. 271).

A girl, æt. 15, with a history of a goitre, uniformly enlarged, for six months, had for several weeks marked dyspnoea, and was said to have been almost suffocated on one or two occasions. The central portion with a part of each lateral lobe was resected. The lateral pressure had almost closed the lumen of the trachea. Removal of the pressure increased rather than diminished the dyspnoea, and on completion of the operation asphyxia was imminent, "the inspiratory efforts completely closing the trachea, which seemed to have lost all power of expansion."* Tracheotomy was performed, the largest tube available being only just sufficient. The remaining portions of the thyroid atrophied, but it was more than two months after the operation before the tube could be dispensed with, and then some dyspnoea and stridor still persisted; these did not disappear until a month later.

The second case, under the care of Dr. Lediard, of Carlisle, is reported by Dr. Stevenson (*Lancet*, vol. i. 1891, p. 1378).

A girl, æt. 16, was admitted for dyspnoea. She had noticed a goitre for two years, and for two weeks previous to her admission there had been great difficulty in breathing. The goitre was a large one, the right lobe being especially hypertrophied. There was marked tracheal stridor. Towards the evening of the day of admission the respiration became greatly embarrassed, cyanosis of the face being well marked, and consciousness being lost occasionally for brief intervals. Under the influence of chloroform the isthmus was removed. No relief of the breathing followed. The right lobe was now taken away, the operation being necessarily hurried, as the patient was *in extremis*. After this step the respiration rapidly improved. The patient made a good recovery, the breathing becoming perfectly normal, and the left lobe subsiding to a quarter of the size it was on the patient's admission.

In the following most instructive case the cause of the severe dyspnoea was a large cyst, post-sternal and intra-thoracic. It was dealt with successfully by drainage by Mr. Bowlby (*Clin. Soc. Trans.*, 1895; *Lancet*, 1895, vol. i. p. 1118). It will be seen that tracheotomy was temporarily required, but that in this case it was possible to keep the two wounds apart by separate dressings.

A woman, æt. 34, had noticed a small swelling in the episternal notch for about two years, and had suffered for the same time from slight shortness of breath. During the

* Perhaps, in addition to the marked narrowing of the trachea, that rare condition, softening of its structure, was also present in this case.

few months preceding her admission into St. Bartholomew's Hospital the difficulties of breathing had increased, and she had suffered from attacks of transient but severe dyspnœa. The attack from which she was suffering on admission had followed on exposure to cold and wet, and was accompanied by bronchitis. The patient was found to be suffering from very severe dyspnœa, with recession of the chest walls and cyanosis. The temperature was 103°. Examination of the neck showed very little external swelling to account for such serious symptoms. There was some fulness in the episternal notch, and the thyroid gland felt a little enlarged. When the patient coughed, however, the swelling increased in an extraordinary manner, a large rounded mass being suddenly extruded from the chest into the neck, and as suddenly disappearing. The swelling moved very slightly on swallowing. Examination of the chest revealed a large area of dullness behind the sternum and cartilages of the first three ribs. There were loud mucous râles in the trachea and bronchi. Incision in the median line showed that the growth was cystic and attached to the left lobe of the thyroid. The trachea was next opened below the cricoid cartilage on account of the cessation of respiration which now occurred, and the cyst incised just above the sternum. The introduction of a feather into the trachea caused the expulsion of some viscid mucus, and after a very short employment of artificial respiration the patient breathed quietly through a large piece of rubber-tubing passed down the trachea for several inches. The cyst was now found to have greatly collapsed, but it still contained several ounces of clear, watery fluid. Mr. Bowlby opened it widely, and discovered that it passed into the chest to a surprising extent. Its capacity was about a pint. It had displaced the apices of the lungs laterally, and extended down to the base of the heart. Its walls were very thin, and were reflected over the large vessels, so that on looking into its cavity the innominate, carotid, and subclavian arteries were seen. The arch of the aorta was similarly prominent, part of the cyst passing in front of it, and part behind. The floor of the cyst rested on the base of the heart, the pulsations of which could easily be seen. Now that the cyst was empty, it was clear that it was attached to the left lobe of the thyroid; it was also evident that the gland, as a whole, was very slightly increased in size, the apparent enlargement being due to the pushing upwards and forwards of the left lobe by the distended cyst. As Mr. Bowlby considered that nothing could be gained by removal of either lobe of the thyroid, and as the cyst itself was irremovable, the operation was completed by carefully stitching the cut walls of the cyst to the adjacent skin. The tube was then removed from the trachea, and the greater part of the tracheal incision sutured. Finally, the cyst wound was so dressed as to shut it off as much as possible from that in the trachea, as suppuration might have caused great danger in a wound so deeply situated. The patient made a good recovery, the opening in the cyst closing in three weeks. Several months afterwards there was no sign of its refilling.

5. Dysphagia, if associated with the other indications now given.

6. Steady or rapid enlargement, with or without dyspnœa, if the enlargement be in a downward direction so as to become sub-sternal. The lower down the growth has been allowed to extend, the greater the risk of mediastinal cellulitis if removal of the bronchocele is attempted, and the smaller the hope of giving relief by tracheotomy if the dyspnœa comes on in these cases too urgently to admit of an attempt at extirpation.

The following case, given by Mr. Bryant (*Surgery*, 2nd ed. vol. i. p. 192), is a good instance of the truth of the above:

A young man, aged 19, three months before his death, "became the subject of paroxysmal attacks of asthmatic dyspnœa, associated at times with a wheezing or whistling respiration, and some general enlargement of the base of the neck. Three days before his death this difficulty became extreme, the paroxysms became more frequent and more severe, and on the day of his death a severe paroxysm took place, which passed on to a forced and heaving respiration, beyond anything I had ever before witnessed, and speedy death resulted. I performed tracheotomy with the slender hope that some light might be thrown upon the nature of the case to guide us in its

treatment, if not to give relief, but, in doing so, what was probable before became evident—viz., that the obstruction was below. I had no perforated instrument with me long enough to force down, so a female catheter was used, but it struck against some solid body that prevented its progress. After death the thyroid body was found to be much enlarged, but mainly below the sternum and along the sides of the trachea. The trachea below my opening was flattened laterally to within half an inch of the bifurcation; it was also twisted to the left, and was surrounded by the greatly enlarged and firm lateral lobes of the thyroid."

7. Inability to stoop without "a sensation of blood to the head," or dizziness.

This was very marked in a man, aged 48, sent to me by Dr. Graham, of Pulborough, with general enlargement of the thyroid, especially of the left lobe. Removal of this and the isthmus was followed by great shrinking of the right lobe, the patient being enabled to follow his occupation of brickmaking in comfort.

8. Inability to sleep lying down.

A woman, aged 38, under my care, whose mother had died at 43 from suffocation by a bronchocele, was much troubled by the above symptom. Entire relief followed removal of the largest lobe and the isthmus.

9. Constant dragging pain in the neck. This will be met with in large and weighty tumours.

10. Improvement of personal appearance. An operation should never be here entertained by the surgeon, unless he is absolutely certain that he may have confidence in himself and his patient that he will be able to keep the wound aseptic from first to last.

11. Exophthalmic goitre. Surgical interference here is considered at p. 697.

Cases in which an operation is contraindicated, or in which it must be performed with additional caution.

1. Huge bronchoceles, especially if broadly fixed. 2. Cases where there has been narrowing of the trachea for some time, interfering with the function of the lungs and thus weakening the heart, especially the right side. 3. Bronchoceles with ill-defined limits. 4. Those which are already sub-sternal, owing to the risk of mediastinal cellulitis. An amount of dyspnoea disproportionate to the enlargement which is visible and a tendency to lividity on exertion may perhaps be present as warnings here. 5. Age—*e.g.*, in patients over 40. I refer here to bronchoceles which are certainly stationary. But as malignant disease usually intervenes not on healthy but on enlarged thyroid glands, it will be justifiable to run risk and to operate about the time of middle life or later, if a bronchocele shows any sign of enlarging. But all bronchoceles which persist should be removed, by competent hands, at a much earlier age, on account of this risk of possible supervention of malignant disease. 6. Patients with a very feeble pulse. Schwartz thinks that feeble action of the heart will be often met with in goitre, and attributes this partly to interference with respiration due to pressure on the veins and the trachea, and partly to the intervention of a more or less voluminous vascular network in the circulation, thus producing a strain on the heart. 7. Cases which appear to be allied to Graves's disease, though not presenting the typical symptoms. I think there is no doubt that there is a class of bronchoceles which form a connecting link

between ordinary goitres and those in which the typical evidence of Graves's disease is present. Such cases are always to be approached, from the operative point of view, with anxiety, as there is a distinct risk of a fatal ending from excessively rapid action of the heart, pyrexia, and perhaps lung trouble. The class I refer to presents many of the following points. The patient is usually a young adolescent, the bronchocele a soft parenchymatous one, affecting the whole gland, with evidently marked vascularity, and perhaps pulsation. The pulse is perhaps 100, and the heart is easily excitable. A soft systolic bruit may be present. Soon after the recovery from the operation the patient becomes restless and anxious. There is a constant attempt to clear the throat by coughing (this disturbs the wound extremely), and the patient complains of a dread of suffocation from a slight collection of mucus in the trachea and larger bronchial tubes. The position in bed is constantly shifted. This may easily lead to loosening of the dressings and infection of the wound, especially at its upper part. The pulse mounts up to 120 or 130, the temperature rises, and exhaustion may soon follow. If the patient's strength is maintained the wound does not heal by primary union. The discharge, at first blood-stained, is profuse for several days, though sweet throughout. While the above train of symptoms, and particularly the restlessness, is likely to be met with after operations on cases of exophthalmic goitre, it certainly follows where the typical collection of symptoms which characterise Graves's disease is absent. Surgeons should bear in mind the class of case to which I have drawn attention above.

Mr. F. T. Paul, of Liverpool, has given the following explanation in an instructive paper (*Brit. Med. Journ.*, Jan. 1, 1898, p. 17). After relating two cases, in both of which the above symptoms followed a few hours after the operation, one case proving fatal, while the other, a case of Graves's disease, recovered, he says:—"These two cases were the twenty-fifth and twenty-sixth operated on for thyroid enlargements, and I have done about ten since. None of the others were at any time dangerously ill, but I can now see that a few of them suffered from the same condition in a minor degree, and at about the same time. I therefore set myself to try and discover what could be the reason that an operation, which at first appeared so safe, should all at once have become so uncertain. Upon looking back, this explanation occurred to me: In the earlier operations I handled the gland very little, tying the vessels on each side before I divided them, and ligaturing the isthmus before separating the lobe. The operations then were longer, and more blood was lost. Indeed, in Graves's disease the hæmorrhage was sometimes alarming, for in these cases the blood wells out of the gland as if it was a saturated sponge. Gradually I came to grasp the gland firmly in the left hand until the thyroid arteries were secured, and in this way found that all serious bleeding was readily avoided. About the same time I gave up ligaturing the isthmus, as it appeared unnecessary. Now in these two changes it was probable that the danger lay. From barely handling the gland it had come to be firmly squeezed during most of the operation, and from securely tying the isthmus it had come to be cut straight across; and it must be remembered that in enlarged thyroids the isthmus is frequently upwards of an inch in diameter. I take it that squeezing the gland may help to liberate secretion contained in the follicles, and that the same may escape into the wound from the lymphatics in the divided capsule round the severed isthmus, the lymphatics being the normal channel for absorption of the secretion. If the condition from which these patients suffered is to be regarded as thyroidism, and not, as Mr. Horsley has said, athyroidism, then every possible source of contamination of the wound with thyroid secretion should be avoided. I cannot recommend that the safe grasp of the gland should be altogether given up; but I believe that it may be rendered harmless by first ligaturing the isthmus, and exercising caution in the amount of compression. My rule now is to ligature the isthmus early in the operation, handle the gland carefully, and at

once, on the barest suggestion of the train of symptoms referred to, open up the wound, irrigate it, and fill with dry, aseptic, absorbent wool." In the first of the two cases related by Mr. Paul in the paper mentioned above, which ended fatally just two and a half days after the operation, the wound at the necropsy contained fluid of a very watery character. Believing that the grave symptoms were due to absorption of thyroid secretion, Mr. Paul, when his second case began to show symptoms which were a repetition of the first, about twenty-four hours after the operation, opened the wound and filled it with dry salicylic wool. This was followed by a marked improvement, but only for a time. During the second night after the operation the patient "became worse than ever; the temperature was $104^{\circ}8'$, the pulse almost uncountable, the respirations 36. I removed the plug of wool, and found it saturated with watery discharge, replaced it with dry wool, and left instructions that it was to be changed as often as it became moist, which proved to be about every two hours. The following day she was better in every way. The day after, the temperature was only just above normal, and continued so until convalescence was established, but the pulse and respirations went down more gradually."

While I avoid squeezing the gland, and limit the handling of it to shelling it out from adjacent important structures, and while I have never seen the watery secretion described by Mr. Paul, the course of the case has, on three or four occasions, so closely resembled that described by Mr. Paul, that I cannot doubt the explanation which he gives of this insidious and sometimes fatal complication is sometimes the correct one. I have below (p. 694) alluded to the question of treatment of the wound in cases which appear allied to the foregoing.

Dangers of the Operation—Immediate and Later.

1. *Hæmorrhage.* This can usually be met by paying careful attention to the details given below in the account of the operation. One of the most important points is to expose the growth thoroughly (1) by a sufficient incision, (2) by adequate retraction or division of the overlying muscles, and (3) by identifying the capsule itself. A mistake is often made here, and the difficulties of the operation largely and needlessly increased. The layers of deep cervical fascia over the thyroid vary greatly in individual cases. Every one must be divided, in the whole extent of the wound, before the bronchocele itself is dealt with. This will be recognised by its peculiar colour (reddish-purple), its consistence, and the way in which the vessels ramify and stand out on its surface. The arteries are usually easily commanded; it is the veins which give trouble, being numerous and thin-walled, and, in the severer cases, met with at every step of the operation. In these cases also, when the growth is soft as well as vascular, any opening of the capsule is liable to give rise to flooding of the wound with blood, which makes it difficult to find the bleeding point, thus incurring risks of including in a ligature or otherwise injuring important parts, such as the recurrent laryngeal. Even in the removal of a small tumour, if soft and rapidly growing, most severe hæmorrhage may be met with, especially if the capsule be opened.

Thus, Mr. Foy (*Dub. Med. Journ.*, 1888, vol. i. p. 242), after shelling out a tumour the size of a hen's egg, met with such copious bleeding that the application of seven clip-forceps gave "no appreciable check to the flow." The wound was plugged with new sponges, kept in place by uniting the wound with wire and figure-of-eight sutures. The patient recovered.

2. *Injury to the recurrent laryngeal nerve, asphyxia, aphonia.* This most grave accident has happened with sufficient frequency to put any surgeon on his guard. The injury may be due to including the nerve in a ligature, cutting the nerve, or seriously bruising it. Richelot,

writing in 1885 (*L'Union Méd.*, Nos. 17 and 18, 1885; *Med. Chron.*, June, 1885), found nine cases in which it was certain that the recurrent laryngeal had been cut during the operation. He gives the following causes of aphonia after the operation:—(1) Wound of inferior laryngeal nerve; (2) dragging of this nerve; (3) perhaps section of the crico-thyroid branch of the superior laryngeal; (4) months after operation it may come on from inclusion of the inferior laryngeal nerve in the cicatrix; (5) when the laryngeal symptoms are progressive from ascending neuritis (Schwartz). This may be present before the operation, and so, too, may be (6) compression of the inferior laryngeal by the goitre.

Whatever be the exact cause, it is certain that the dyspnoea and aphonia are not always permanent. On this point the two following cases of M. Richelot, and my own, are of much interest:

In a woman, aged 25, suffering from suffocating dyspnoea, the operation was followed by aphonia, which lasted for three months, and by complete paralysis of the cords. The operation was performed with great care, and there is no reason to think that either of the recurrent was cut, but it is possible that they were bruised or stretched; however, in four months the cords regained movement and the voice was fully restored.

In the second case, aged 20, a hard, mobile tumour, the size of a walnut, was attached to the isthmus by a narrow pedicle, and the gland itself, though apparently somewhat hypertrophied, was not prominent. But, when exposed, it was found that the tumour had a broad attachment to the isthmus, and that the two lobes of the thyroid were greatly hypertrophied, closely embracing and compressing the trachea; it was therefore thought desirable not only to remove the tumour, but also to dissect out the whole gland. When recovering from the effects of chloroform, the patient was suddenly seized with cyanosis and threatening asphyxia, and though she partially recovered, on the next day there was aphonia, dysphagia, and uninterrupted dyspnoea, and she died asphyxiated in the evening. Both recurrent laryngeals had been cut, and the upper end of the left one was included in a ligature.

In June, 1894—this being my fifteenth case of removal of the isthmus and one half of the thyroid—I met with this complication, which was, however, not permanent.

The patient was aged 35, the subject of an ordinary solid bronchocoele, of large dimensions, the right lobe being seven inches long. The voice was decidedly weak before the operation, but while this presented no difficulties and was not accompanied by any cyanosis, dyspnoea, &c., it was followed by marked aphonia, the voice being almost reduced to a loud whisper. The right vocal cord was now found to be motionless. Complete recovery had taken place in April, 1895. In February, 1899, I saw this patient again, on account of a Colles's fracture. Her voice was good, though a little weak. Since 1895 she had been following her occupation as a cook.

Injury to the nerve is especially likely to occur under the following conditions: (a) when the growth is huge; (b) when it is very fixed by adhesions (which are uncommon), or by a broad base; (c) when it is ill defined; (d) when it encircles the trachea and œsophagus closely; (e) when it is malignant. Advice as to the avoiding of this complication is given at p. 693.

3. Cellulitis leading to purulent and diffused mediastinitis. These are very likely if the wound becomes infected. In such cases the latter complication is almost certain, even in small goitres, if they dip down behind the sternum, owing to the difficulty of providing adequate drainage. The accompanying symptoms are pain in the region, coming on soon after the operation and increasing, followed by feebleness of the pulse, distress, and dyspnoea, and speedy death.

4. Myxœdema, both acute and more deferred. This strange condition, which has so unexpectedly overclouded otherwise successful operations for complete removal of an enlarged thyroid gland, was first noticed and published by two Swiss surgeons, Kocher and Reverdin.* The correct explanation will probably be found to be the one which Sir V. Horsley brought before the profession in his lucid and convincing Brown Lectures of 1885.† The issues here treated are so wide, the experimental researches are so complete and far-reaching, that any abstract must, unintentionally, seem to do them an injustice. The following are the points of chief importance to the operating surgeon:

Effects of Excision; Phenomena following Complete Thyroidectomy in Monkeys.—"At a variable period after the operation, but averaging five days, the animal is found to have lost its appetite for a day or two, and, on closer examination, to exhibit slight constant fibrillar tremors in the muscles of the face and hands, and feet more especially. These tremors disappear at once on voluntary effort. At the same time, the animal is noticed to be growing pale and thin, in spite of the appetite, &c., returning quickly with great increase; rapidly the tremors increase, affect all the muscles of the body without exception; the animal becomes languid, paretic in its movements, and imbecile. Then puffiness of the eyelids and swelling of the abdomen follow, with increasing hebetude. During these last stages the temperature, gradually falling, becomes subnormal, and then the tremors disappear as they came. Meanwhile the pallor of the skin often becomes intense, and, leucocytosis having been well marked, oligæmia follows, and the animal dies perfectly comatose in a variable period, but usually about five or seven weeks after the operation."

Further detailed and most interesting information is given by Sir V. Horsley, "The Functions of the Thyroid Gland" (*Brit. Med. Journ.*, 1892, vol. i. pp. 215, 265), and in his report as a member of the Clinical Society's Committee on Myxœdema, 1888. In the former of these papers (p. 268) he states his view as to the explanation of the myxœdema which may follow on complete thyroidectomy, as follows: "The thyroid gland possesses a power of metabolising certain intermediate waste products; if this metabolism should be interfered with, the consequence was disorganisation of the chemical changes (more especially those of the connective tissues), resulting in the imperfect performance of their normal processes, and consequently in their exhibiting this form of mucinoid degeneration."‡

* *Arch. f. Klin. Chir.*, Bd. xxix. S. 254, 1883.

† *Brit. Med. Journ.*, Jan. 17 and 31, 1885: "The Thyroid Gland: its Relation to the Pathology of Myxœdema and Cretinism, to the Question of the Surgical Treatment of Goitre, and to the General Nutrition of the Body."

‡ Sir Victor thus tabulates the most striking of the anatomical and physiological facts bearing upon experimental myxœdema:

"1. The thyroid gland appears to consist of two distinct portions—(a) glandular, consisting of highly vascular acini, which excrete into their interior a mucoid substance, this substance, or something closely similar, being found in the lymph-vessels of the gland—mucin-excreting function? (b) highly vascular, lymphoid nodules—hæmatogenous function.

"2. Excision of the gland is followed, according to my experiments, by an increase in the amount of mucin in the tissues which normally possess it, by a retrograde histological change, by an increase in the activity of the glands which normally excrete it, and, what

The following cases, with the results of operation, support Sir V. Horsley's views. They might be multiplied by other published cases, and it is probable that many other temporarily successful thyroidectomies have been followed by myxœdema, but that this ending of the cases has not been made known.

Volkovitch, of Kiev (*Lond. Med. Record*, 1885, p. 148), removed the whole gland, in a woman aged 38, for dyspnoea and dysphagia indicating operative interference. Death took place four months later, with marked evidence of "cachexia strumipriva"—i.e., anæmia and weakness, tetany of hands and legs setting in five days after the operation, and becoming, later on, more general, numbness of hands, myxœdematous condition of the integument, striking apathy, and difficulty in articulation and respiration.

The late Sir W. Stokes published (*Brit. Med. Journ.*, Oct. 16, 1886) a case in which a somewhat similar fatal result followed complete thyroidectomy. A healthy woman, aged 18, was admitted with extensive enlargement of both thyroid lobes, causing urgent dyspnoea, especially at night. It was found impossible to remove more than the left lobe owing to the profuse hæmorrhage, which almost proved fatal. A good recovery took place, followed, for a while, by relief of dyspnoea and diminution in the size of the right lobe. In about six weeks, however, the right lobe was as large as before, and the thrill and dyspnoea were again present in an intensified form. The right lobe was removed with even greater danger from syncope. Within a fortnight convulsive seizures set in, and "fatty" swellings were noticed about the eyelids, backs of the wrists, and over the metatarsi. Mental torpor also appeared, and the aspect of the face became gradually one of imbecility. The convulsive seizures recurred, with lividity of the face, stertor, dyspnoea, protrusion of eyes, dilatation of the pupils, and throbbing of the carotids, followed by copious perspiration. The patient became weaker, and died with symptoms of pulmonary infiltration, ten days after the second operation. The very brief account of the necropsy only mentions the brain, heart, and lungs; of these the two former "contained nothing abnormal; the lungs were highly œdematous."*

v. Mikulicz stated, some years ago, that the published cases of "cachexia strumipriva" after thyroidectomy already numbered thirty-five, and he adds another. As to other evils which may result from total thyroidectomy, he says that Weiss, in 1883, found thirteen cases of tetany, and v. Mikulicz himself had had four cases in seven operations. He also cited three cases (two of his own) in which epileptic convulsions followed total extirpation. The following is a most instructive case of fatal tetany after what amounted to a complete removal of the gland, published by a surgeon of large experience, Prof. Madden, Cairo School of Medicine (*Lancet*, June 20, 1903, p. 1729). A girl, æt. 12, had a large trilobed bronchocele, so easily shelled out that the operator was tempted to remove it entirely, leaving a piece of the isthmus the size

is still more striking, by the assumption of the muciparous function by a gland which normally produces none, or very little mucin—the parotid gland.

"3. Excision of the gland is followed by profound changes in the blood—namely, a diminution of the number of corpuscles, preceded, as regards the number of the white elements, by a temporary increase in their number, by an alteration in the coagulability and albumins, and by an abnormal presence of mucin.

"4. Excision of the gland is followed by nerve symptoms indicating changes in the lowest motor centres, these changes causing tremors, with rigidity and paresis; it is also followed by changes in the higher psycho-cortical centres, such producing imbecility, and, ultimately, death in the comatose state."

* In a similar case I would advise either ligature of the vessels to the remaining lobe, or removal of half of this. Possibly the administration of thyroid extract might have been beneficial.

of a walnut. On the third day there were signs of tetany, which disappeared when thyroid tabloids were given. As marked emaciation followed maltine was substituted. On the twelfth day the tetany reappeared. The tabloids were again given, but now had no effect. Twenty-four days after the operation death took place in an attack of tetany, general, but especially affecting the respiratory muscles. The necropsy showed no trace of thyroid tissue. The bit left had atrophied completely.

It is right to state that other observers have failed to trace the above sequence. Foremost among these is the experience of Billroth, who, in 1883, had performed extirpation sixty-eight times, with a mortality of only 7·3 per cent., and without once observing "cachexia strumipriva." Créde, of Dresden (*Congress of German Surg.*, 1884), reported fourteen cases of complete extirpation without one case of myxœdema following.

In the laborious Report of the Clinical Society of Myxœdema it is stated (p. 171) that myxœdema with cachexia followed in about 33 per cent. of all cases of complete thyroidectomy. Many cases will be found there quoted.

However this matter may finally be cleared up, the fact remains beyond dispute that in many parts of Europe symptoms akin to those of myxœdema have followed complete thyroidectomy.

Sir V. Horsley (*loc. supra cit.*) shows that the following are modifying conditions in this consequence of thyroidectomy:—(1) The animal in question. Thus, while most severely marked in carnivora, he speaks of the cachexia as moderate, but certain, in man. (2) The age.* (3) The existence of accessory and residual thyroid tissue. (4) The previous state of nutrition, a state of low nutrition before thyroidectomy leading to early and very severe cachexia.

Why this sequence has not been invariable, and what the explanation of it is when it does appear, are as yet uncertain. But till this matter is cleared up, I am distinctly of opinion that complete extirpation of the thyroid is as yet unjustifiable in young subjects, or before the approach of middle life.

The following case is the only one in which I have removed the entire thyroid. The points worthy of note are (1) that an interval of five years took place between the two operations by which removal was effected; (2) that the woman was 41 when the second lobe was removed, and that, though no thyroid extract was being taken, she was perfectly well when seen a year and seven months after the second operation; (3) that the diminution in size of the remaining lobe which followed on removal of the first and the isthmus was not permanent.

H. W., æt. 36, was sent to me at Guy's Hospital in February, 1893, for general enlargement of the thyroid gland. This had commenced when the patient was 16, then remained stationary till her marriage at 21. After each pregnancy the swelling had increased, and then gradually subsided. Following the birth of her last child, fourteen months before, the swelling had not subsided. The patient now had dyspnoea after exertion. As the left lobe had originally been the first to enlarge, and as it was now

* Of Kocher's sixteen cases, in which "cachexia strumipriva" was developed, nine were under twenty years of age, five between twenty and thirty, and only two above thirty. Eleven were young women; five were males.

softer and more vascular than the right, this lobe and the isthmus were removed on February 17, 1893. The patient left the hospital on March 20, the wound being soundly healed. It is stated in the report that "the right lobe had diminished rapidly, all that was left of it being a small squarish mass."

In June, 1898, or more than five years later, the patient reported that she was troubled with her breathing, and that after a long interval, being three months pregnant, she was very anxious about herself owing to the enlargement of the gland in previous pregnancies. She was readmitted on June 28, 1898. The right lobe was about twice its proper size. There was no tracheal stridor. The right lobe was removed on June 28, the patient being now 41. She left the hospital on July 12, the wound being entirely healed. She took the thyroid extract for two months only, went her full time, and bore a healthy child. I saw her in February, 1900, a year and seven months after the removal of the second lobe. There was not a trace of myxœdema; the general health was excellent.

Operation for Removal of One-half, and the Isthmus as well if required.*—I recommend this operation most strongly. I have performed it in 41 cases of ordinary bilateral bronchocele, and in 4 of exophthalmic goitre. Of these 41 cases, two were over 50. Both recovered. Three of the cases died, one a young male, with an enormous and rapidly increasing bronchocele extending behind the sternum, and causing grave dyspnoea. This patient sank within twenty-four hours, with symptoms which now appear to me referable to absorption of thyroid secretion (p. 684). But in every case of so-called thyroid toxæmia the question should always arise, Is it one of acute septicæmia? The other, a woman of 44, died without any cause being found, save bronchitis. This may quite possibly have been due to infection. The third fatal case was one of exophthalmic goitre, and is recorded below (p. 700).

In the very great majority, shrinking of the opposite half of the thyroid followed. In two cases—and it was not till I had operated thirteen times that I became familiar with this possibility—this desired end was only temporarily attained. After a few months the shrinking of the opposite lobe ceased, and it began again to enlarge. One patient I lost sight of; the case of the other is related above. It will be seen that the re-enlargement of the second lobe here caused no stridor, and that the dyspnoea was probably exaggerated and of nervous origin, the patient having suffered from real dyspnoea in past pregnancies, and having, after a long interval, become pregnant again. The four cases in which I have operated for exophthalmic goitre are given below (p. 698). Any administration of thyroid tabloids should be stopped a week before any operation. Sterilisation of the parts must be far-reaching and thorough, including a wide area over the sternum, and the cleansing of the axillæ, under which the bandages will pass for security. The patient's head and shoulders are conveniently supported, and the anæsthetic is administered, A.C.E. being usually the best. If ether is thought necessary, it should be replaced by chloroform as soon as its stimulating effect is established.† The incision chosen must be

* I have (p. 695) compared this operation with one preferred by many surgeons, viz., removal of the adenomata which they maintain to be usually at the root of enlargement of one or both lobes of the thyroid.

† Prof. Kocher "substitutes cocaine for a general anæsthetic. Nervous and sensitive patients with healthy lungs and heart may be anæsthetised with a mixture of air and ether without hesitation."

sufficiently free to enable hæmorrhage to be efficiently met, and every part of the lobe operated on to be seen. If the "collar" incision is employed one end will require to be well curved upwards to expose the superior thyroid vessels. At the same time the incision here is not to be higher than needful; otherwise the wound is brought near a source of possible infection, the mouth. Whatever incision is used, it may become keloid occasionally even after primary union. In my experience this is only a temporary condition. While an ample oblique incision along the anterior border of the sterno-mastoid curved over to the opposite side below will nearly always give all the room required and a scar that will be little conspicuous, and is the one I have usually employed, many prefer now to make Prof. Kocher's "collar" incision. This is a transverse incision across the neck slightly curved upwards at its two extremities. It is made at a higher or lower level according to the position of the swelling, in most cases just below the cricoid; in those which dip into the thorax it is placed just above the episternal notch.

The skin and platysma being cut through, any superficial veins carefully tied, the deep fascia is slit up, and one or more of the depressors of the hyoid bone, often much expanded, are next met with. These are separated with a blunt dissector, and divided if needful. I wish here to impress three points upon my juniors. The first, that all handling of the gland is to be as gentle as possible, for the reasons given at p. 684; and this is especially the case with soft, parenchymatous goitres. Secondly, a pair of blunt-pointed curved scissors make a most efficient blunt dissector when used closed, while they are at hand in a moment to divide any structure required. Prof. Kocher's enucleator is shown in Fig. 256. Lastly, as I have emphasised at p. 685, the layers of deep cervical fascia met with vary much in strength, and, to a less degree, in number also. Every one of them must be divided in the full extent of the wound before any attempt is made to deal with the bronchocele itself. Inattention to this point will largely increase the difficulties met with. The goitre in its capsule will be recognised by its bluish-red colour and the large veins which stand out as they ramify on the surface of the gland. One or more large retractors are now inserted so as to draw outwards the sterno-mastoid and large vessels, while the surgeon with his left index finger, or the scissors, frees the enlarged part of the thyroid from its bed, shelling it forwards, and probably finds it only fixed above, below, and internally, by the thyroid vessels and the isthmus. In effecting this separation, the greatest care must be taken to work gently and to keep close to the tumour,* the veins being often much enlarged and thin-walled. The upper extremity

FIG. 256.



Prof. Kocher's enucleator for operations on the thyroid and tuberculous glands. (Down Brothers' Catalogue.)

* The capsule proper of the tumour must nowhere be opened. Such a step not only leads to flooding of the wound with blood, but thus also obscures and may lead to damage

of the tumour being first isolated, the superior thyroid vessels are found and carefully secured. This effected, the tumour is next isolated in a downward direction, and any outlying masses turned out from beneath the sterno-mastoid. The next step usually taken is similar isolation, ligature, and division of the inferior thyroids, but I prefer to take the isthmus next, being of opinion that the more the growth is freed and isolated, and the less fixed it is, the more easily is the inferior thyroid artery dealt with, and the less danger is there of damaging the recurrent laryngeal.

The separation of the isthmus is best effected with a steel director, care being taken to keep the isthmus as much off the trachea as possible, and the point of the director close to the isthmus. Mr. W. Spencer has published a very interesting case (*Ann. of Surg.*, May, 1895) in which the isthmus and the trachea were most intimately united, although the thyroid gland seemed the seat of fibroid and not malignant degeneration.

The patient was a young woman with a thyroid normal in size and shape, but of marked hardness. The pulse was 130-140. There was no exophthalmos. Stridor was present, loudest at the level of the isthmus. At the operation, no line of demarcation could be made out between the isthmus and the trachea, so the isthmus and the adjacent part of each lateral lobe were shaved away from the trachea, leaving a portion about as large as the end of the thumb. The trachea thus exposed felt like a soft tube, and was sucked in and blown out by inspiration and expiration. The cartilaginous rings had softened or disappeared. As the breathing was none the better for the removal of the isthmus, the trachea was opened immediately below the cricoid cartilage. The lumen below this point being seen to be narrowed to a chink, the incision was carried downwards through that part of the trachea which had been in contact with the thyroid, until cartilaginous rings were again met with. In a fortnight the patient was able to discard the tube, and she made a good recovery, though the pulse-rate was still 120 a minute.

When the isthmus has been sufficiently separated, it may be ligatured after transfixion with an aneurysm needle carrying sterilised silk,* or it may be carefully torn through with the point of a director, and each bleeding point secured. The latter step will usually suffice.† The amount of hæmorrhage met with in detaching and dividing the isthmus varies. If the separation is effected piecemeal, the bleeding is often very slight. This is probably accounted for by the fact that the intimacy of connection and continuity of structure between the halves of the thyroid and the isthmus varies much also; in many cases

of important parts, *e.g.*, the recurrent laryngeal and trachea. By the capsule proper I mean the thin sheath of the gland which gives off numerous septal processes into it. Every layer of fascia above this, including the sheath from the pre-tracheal layer of deep fascia, must be divided.

* If by any mishap primary union be not secured, the silk ligatures will be liable to come away for many months. Hence some prefer sterilised chromic gut.

† If the pedicle seem too thick and vascular to treat in this way, Prof. Kocher advises crushing it in powerful clamp forceps. When these are taken off only the connective tissue and vessels are left. The latter can now be ligatured *en masse* in the much diminished pedicle. Where such forceps are not at hand, the isthmus should be subdivided and tied in several pieces, like a stout ovarian pedicle, the ligatures being made to interlock.

the connection is mainly by connective and a little glandular tissue, with very few vessels.

The tumour, now almost completely isolated, is dislocated to the opposite side, and especial care is taken before ligaturing the inferior thyroid artery. This should be most carefully isolated and inspected, so as to avoid injury to, or including, the recurrent laryngeal. Owing to the fact that the trunk of the inferior thyroid artery does not come into relation with the recurrent laryngeal till both are close to the trachea, either the trunk of the vessel should be ligatured and cut at some distance from this tube, or its branches tied close to the gland. I prefer the latter course.

If the vessel be tied near the junction of cricoid and trachea, the nerve may very likely be included; and the same risk will be run if, at this stage especially, the wound be not kept dry and bloodless. The inferior thyroid vein descending from the isthmus and lateral lobes, in my experience, bleeds very little after the arteries have been secured. The thyroidea ima vessels have never caused me any trouble.

After the removal of the tumour, the wound should be examined for any bleeding points, and most thoroughly dried out.

The question of **drainage** now arises. The wound left after removal of one lobe only, if much enlarged, is often extensive and deep, the larynx, trachea, large vessels, and œsophagus being all exposed. In several of my cases the dome of the pleura has been seen rising and falling in the root of the neck. It is a very difficult wound to drain satisfactorily, as its lower part dips behind the sterno-clavicular junction. In cases of ordinary parenchymatous bronchocele, where the operation has been easy, and the parts but little disturbed, the surgeon will dispense with all drainage and trust to a dry wound and carefully-applied pressure so as to obliterate its cavity. In such cases, in order to obviate any collection occurring, all fluid, blood-clots, &c., should be most thoroughly sponged out before the wound is brought together, and gauze or a sterilised pad should be kept in the wound while the sutures are inserted. These last are best of sterilised salmon-gut and horsehair. When they are all in place the gauze is withdrawn before the sutures are tied. The edges of the wound should be brought into most exact position to promote early and sound healing. Over the dressings in immediate contact with the wound, firm even pressure should be made with sterilised pads or salicylic wool, with the twofold object of distributing the discharges evenly over a large surface of dressings, and obliterating the cavity of the wound. And for the first week after the operation the same care should be taken to keep the dressings securely in position. This is especially difficult in a mobile part like the neck, and one which does not admit of much compression. The safest plan is to pass the gauze bandages under the axillæ (protected from chafing by wool) below, and to wind them over the chin and forehead above, all being made secure by continuous stitching. This alone will prevent the dressings slipping down and exposing the upper end of the wound, which is thus readily infected. A piece of jaconet should be so arranged as to prevent soiling of the upper dressings by discharges from the mouth. In certain cases it will be wiser to employ some form of drainage. Thus, in rare instances, where much disturbance of the parts laterally

has been needful—in one of my cases the common carotid was displaced into the posterior triangle—it may be well to introduce a tube laterally by counter-puncture. In those cases of soft vascular parenchymatous goitres where the train of symptoms described at p. 684 is so prone to follow—due, perhaps, as pointed out by Mr. Paul (p. 684), to absorption of thyroid secretion—and in all cases of exophthalmic goitre, it might be well that salmon-gut sutures should be inserted, as advocated above, but not tied; the wound should be gently but thoroughly plugged with dry sterilised gauze (a note being taken of the number of pieces used) secured with silk. The sutures are left long, and the wound is dressed in the usual way. After two days, when there is no longer any danger of further escape and absorption of the thyroid secretion, the gauze would be removed (with the aid of nitrous oxide gas if needful) and the sutures carefully tightened.

One or two complications require notice.

If during the operation there is any evidence of syncope, the head should be lowered and injections of ether or brandy given. It is always well to have the means of giving oxygen at hand. Both the surgeon and the assistant who is giving the anæsthetic must be on the look-out for evidence of dyspnœa or asphyxia. If any sign of these occur, it is an indication for the surgeon most carefully to examine the tissues which he is handling, and the amount to which he may be dragging upon the air-passages in the manipulation of the tumour. As a rule any dyspnœa which has been present before and increased by the operation is greatly relieved by the slitting up of the deep fascia and displacement forwards of the goitre.

Tracheotomy is frequently a fatal complication,* partly by infecting such a deep and important wound, partly by causing broncho-pneumonia and partly by adding to the shock in a patient already collapsed by so severe an operation.

If tracheotomy appear urgently needed, the surgeon should try first slitting up more freely the deep cervical fascia or dividing any stretched muscles, in order to relieve the trachea and breathing.

In the event of this operation having to be performed, great difficulties may be present, and the surgeon should be provided with long soft tubes, in case there is any mediastinal prolongation pressing upon the lower part of the trachea. Every possible attention must be paid to keeping the tracheotomy wound as sterile as possible.

Bronchoceles with Intra-thoracic Extension.—In young subjects, where the extension is moderate in amount, where the bronchocele has not had time to become wedged in by continuous pressure, no especial difficulties will be met with. The earlier steps are the same as those given already. The upper part of the swelling is dealt with, the superior thyroid vessels tied, the isthmus divided if possible. The depressors of the hyoid bone will have been divided, and in these cases the sternal head of the sterno-mastoid may also be cut through. In addition to a sterilised finger, blunt elevators, that of Prof. Kocher shaped like a large spoon, will be useful in loosening the intra-thoracic portion. Where this is too large for delivery through the aperture of the

* In five of Billroth's cases in which tracheotomy was performed, three died. Kocher's experience has been the same.

thorax, Prof. Kocher advises "exenteration, the size of the tumour being diminished by breaking up and removing the colloid material piecemeal. The bleeding is so severe that the tumour, after being diminished in size, must be drawn as quickly as possible to the surface in order that the vessels may be tied. If it has not been possible to tie the inferior thyroid artery previously, this must now be done, and therefore the tumour must not be pulled out too suddenly. If, in spite of every care, the artery is torn, the bleeding may be stopped by firm pressure with the finger downwards and outwards, until the vessel can be caught, which must invariably be done. Packing the wound to arrest hæmorrhage is a bad procedure." Where the intra-thoracic projection is cystic, Mr. Bowlby's case (p. 681) shows how this should be dealt with.

Enucleation of Thyroid Adenomata.—This method has been largely used by Porta, Billroth, Socin, Reverdin, Wölfler, and other Continental surgeons. Mr. Symonds (*Clin. Soc. Trans.*, vol. xxiii. p. 51) considered that it is sufficient and a much less severe operation to enucleate these instead of removing one-half of the gland. In practising enucleation it is necessary, when the enlarged lobe has been exposed and brought well up into the wound, to search for and define most accurately the capsule of the adenoma. "In most cases it will be seen at once, but in a few the edge of the gland may have to be raised first. It is most essential to be sure that the smooth, white covering is exposed, for if not, and the dissection be carried outside it, troublesome hæmorrhage is sure to follow; in fact, the entire success turns upon this point." Any surgeon adopting this method will remember (1) the above danger—a very present one—of hæmorrhage*; (2) the fact that these adenomata may be multiple,† and that if one be left behind it may later bring about enlargement of the lobe; (3) that shrinking of the opposite lobe, which it is our aim to bring about by removing one lobe, is not so likely to follow on removal of an adenoma as it is when one lobe and half the isthmus have been removed; (4) that enucleation is not applicable to all cases, *e.g.*, the gelatinous form of adenoma, the multiple cases or where a single one lies deeply.

To quote Mr. Berry (*Birmingham Med. Rev.*, 1890, p. 332), the method is obviously suited only to those cases in which the adenoma forms a well-defined tumour embedded in the thyroid. Again, as pointed out by the same authority (*loc. supra cit.*, p. 332), it is only in the unilateral goitres that the enlargement is brought about either by adenomata or cysts. In my experience, unilateral goitres present themselves for treatment but rarely when compared with the cases of general enlargement. A careful examination of the specimens removed in the forty-one cases in which I have operated has revealed single adenomata in only five, and one of these lay too deep to be detected. In the other cases they were multiple, and often too soft for enucleation.

* Wölfler, in his exhaustive monograph (Berlin: A. Hirschwald, 1891), shows that this method, while successful in a great majority of cases, has proved fatal from hæmorrhage. Mr. Berry (*Lancet*, May 3, 1902) has seen cases of death from this cause, and has heard of others.

† Wölfler (*loc. supra cit.*) mentions a case in which as many as thirty or forty adenomata were present. He states that recurrence took place in one case after this method had been employed, but that, as most of the cases are too recent, nothing definite can be stated on this point.

For the above reasons I do not recommend enucleation. But the words of Prof. Kocher will be conclusive, "It is the simplicity of the procedure that frequently misleads the inexperienced into giving it the preference over excision. It is attended with more serious hæmorrhage than excision, because bleeding and general oozing occur from numerous small vessels in the capsule which is left behind. On this account, as well as from the fact that it does not ensure a radical cure,* it is not a good method to employ." The same authority would only perform enucleation "(1) when the other half of the thyroid is atrophied, or has already been removed; (2) when only one or two isolated nodules are to be felt in otherwise healthy gland tissue; (3) when a single nodule exists which has caused extensive pressure atrophy of the surrounding gland structure, so that vascular gland tissue is only present to a limited extent, generally posteriorly; (4) when the goitre is very adherent to the external capsule as a result of inflammation."

Cases of Bronchocele which persist or recur after other Operations.

—These are extremely rare after removal of one-half of the thyroid. I have referred (p. 690) to the only cases which I have met with. After enucleation this is much more common. Brunner has shown that of 18 per cent. of recurrences after thyroid operations the majority were after enucleation (Kocher). These recurrent cases are rendered difficult (a) by the presence of the scar of the previous operation, (b) by the fact that myxœdema and tetany are liable to follow complete removal in a young subject.

Prof. Kocher's advice is as follows: The remaining lobe is isolated in the usual way, access being gained laterally; and where the cicatricial adhesions cause much difficulty, the scar should be removed with that part of the goitre which is resected. If the upper part of this appear healthy, the superior thyroid vessels are not tied; sufficient of the gland is left connected with them, its junction with the rest being crushed through; the crushed lower part is then ligatured and removed according to the directions already given. If the upper part is diseased, the superior thyroid vessels are first tied, the goitre is then displaced, the thyroidea ima veins ligatured, and the goitre separated from the trachea. Partly by crushing, partly by careful enucleation of colloid material from within the capsule, a pedicle may be formed which can be ligatured. Thus sufficient thyroid tissue is left below, nourished by the inferior thyroid artery. The upper portion is removed. Some form of efficient crushing-forceps is essential.

Treatment of Enlarged Thyroid by Operations on the Isthmus.—This method consists in excising the isthmus after applying double ligatures. It was first recommended in this country by Sir D. Gibb (*Lancet*, 1875, vol. i. p. 120), and more recently by

* Dr. Cumston (*Boston Med. and Surg. Journ.*, Dec. 27, 1900) relates a case which demonstrates the fact on which Prof. Kocher has insisted that "when once the trachea has been completely freed on one side by the total extirpation of one lobe of the thyroid, though a recurrence may occur in the other lobe, the trachea, remaining free on one side, will never be compressed by the newly formed goitre so as to produce difficulty in respiration. This in no way applies to enucleation, because, after this operation, the trachea remains surrounded by thyroid tissue."

Mr. Sydney Jones (*Lancet*, Nov. 24, 1883). Much relief followed, especially as to the dyspnoea present, in the three cases reported.

In three cases, in which I removed the isthmus alone, the shrinking of the lateral lobes was steady and progressive. I cannot, however, say whether this has been permanent, and as in two cases, in which I had removed one lateral lobe as well as the isthmus, the other lobe, which had shrunk out of sight, began two or three years later to enlarge again, I have ceased to practise removal of the isthmus alone. But where dyspnoea is increasing, and slitting up of the deep fascia freely does not relieve it, especially in cases where the surgeon is short-handed, a trial of this method would be quite justifiable, though, as shown at p. 681, one lateral lobe should always be removed as well, if possible.

A trial of this operation would be also justified in the following cases: when the isthmus is distinctly enlarged in (a) cases of colossal growths, where the surgeon does not care to undertake more*; (β) where, owing to the anæsthetic not being well taken, the time for operation is limited; (γ) where, the lateral lobes being little affected, the isthmus is the seat of the enlargement, especially if tracheal stridor be present; (δ) in some cases of exophthalmic goitre, especially if dyspnoea be present. If with general enlargement dyspnoea be present, removal of one of the lateral lobes as well as the isthmus will give much more speedy and decided relief. I accordingly prefer the latter operation wherever the lateral lobes are much enlarged. The isthmus can be raised without difficulty with a steel director or blunt dissector from the trachea; it is then transfixed at its junction with the lateral lobes, or through these themselves, with a double sterilised sulphuro-chromic gut ligature (this should be tested beforehand). The ligatures being tied, the gland tissue is snipped through between them, the isthmus removed, and the stumps pared away as close to the remaining ligatures as is safe.

Surgical Interference in Exophthalmic Goitre.—I am of opinion that any one who candidly reviews all the work which has been done in recent years, and who has a personal experience in this matter, will come to the conclusion that the results often claimed are not yet justified. The risks of operation—and I refer especially to partial thyroidectomy—are enormously increased. In addition to the risks specified below, the resisting power of these patients is always very low. The cure claimed so often is rarely a complete one,† if the cases are duly watched. Thus the exophthalmos is lessened; the pulse becomes less rapid; the tremors are abated; but, after a time, many of these troubles are liable to return. The most that can be said is that the patient is not cured, but her life rendered one of a fair amount of comfort. And until we know what is the pathology in each case, whether it is an excess or a perversion of the secretion, how far the origin of the disease is a nervous one, we cannot expect that surgical treatment should fulfil one of the chief claims ever made on it, and run on rational lines.

The following appear to me to be the chief indications and contraindications to surgical interference. *Indications.*—Where carefully tried medical treatment has failed, where the goitre is increasing,

In these cases the shrinking of the lateral lobes may be slow.

† Dr. Frank Hartley's experience (p. 702) is, I consider, an exceptional one.

especially in the downward direction, and above all where it is causing dyspnœa, also in the extremely rare cases of threatening ulceration of the cornea. The condition of the heart, which in many cases has led, with the necessarily contributing conditions of the operation, to fatal syncope on the table, must also be estimated carefully. *Contra-indications.*—Very acute cases, or where an acute stage has supervened upon a more chronic one. Such cases should be treated by absolute rest, the local application of ice, &c. If no improvement follows, and if dyspnœa is not present, operation is only to be undertaken after both sides have been placed before the patient; in such cases eucaïne may be tried, oxygen should be at hand, and the details given below (p. 703) with regard to partial thyroidectomy in these cases should be carefully attended to. Persistent nausea, vomiting, and diarrhœa, are, of course, contra-indications, not only from their bearing on the vitality of the patient and tendency to syncope, but also from the necessary risk of disturbance of the dressings. Any evidence of myxœdema must be weighed together with other conditions present. Dr. E. Rixford (*Trans. Amer. Surg. Assoc.*, vol. xxi. p. 347) performed partial thyroidectomy in a patient æt 29, where some evidence of myxœdema was present. Two years later she was "practically well." Marked emaciation would deter me from interfering.

The operative procedures from which a choice has to be made are the following. (1) Removal of one-half of the thyroid and the isthmus. (2) Removal of the isthmus. (3) Ligature of the thyroid arteries. (4) Exothyropexy, or division of the deep cervical fascia and displacement of the thyroid forwards, the object being to relieve any dyspnœa and to bring about atrophy of the bronchocele. (5) Removal of the cervical sympathetic.

(1) *Removal of half the thyroid and the isthmus.*—I have operated in this way four times. It will be seen that in the two cases in which particulars have been obtainable some time after the operation the relief given has not been complete, further that the fourth case was quickly fatal, probably from thyroidin poisoning.

The first case was a patient, aged 22, of Dr. Garrard, of Rickmansworth. I operated with the approval of Dr. Goodhart. Proptosis had been noticed for three years, but the enlargement of the thyroid for only six months. Both lobes, especially the right, and the isthmus were much enlarged, the latter extending down to the sternum. The whole gland was spongy, and pulsated slightly, in addition to receiving pulsation from the carotids. A marked thrill could be felt over it. A venous bruit could be heard at the lower part of the right lobe, a systolic bruit over the pulmonary, and one much less marked over the aortic area. Slight attacks of dyspnœa had recently appeared, especially at night, "with wheezing." There was occasionally some difficulty in swallowing. Chloroform was taken quietly. An incision, about seven inches long, being made from behind the right angle of the jaw to the left sterno-clavicular joint, the tumour was exposed by slitting up the deep fascia and partly dividing, partly retracting, the hyoid depressors. The three parts of the thyroid were intimately fused, thick, and fleshy; the isthmus had crept down to the manubrium. A very striking feature was five or six huge veins, the size of the axillary, coursing over the front of the tumour to dip down behind the sternum. The thyroid vessels on the right side were first found and tied, the inferior being dealt with by tying its branches very close to the gland, so as to avoid the recurrent laryngeal nerve. The right lobe was then dissected from the trachea with a steel director, the adhesions being intimately close by firm connective tissue not very vascular. The large veins already mentioned having been secured with double sulphuro-chromic gut ligatures, the isthmus was next freed from the trachea and its junction with the left lobe carefully transfixed

with a steel director. Along the director an aneurysm-needle loaded with stout gut was passed. The loop of this was drawn through and cut, and the two halves of the above junction tied tightly. The right lobe and the isthmus were then cut away. Recovery was most satisfactory, the patient being up on the eleventh day. There was still some throbbing over the left side, but this was no longer perceptible to the patient. The basic bruits had disappeared. This case, which has now been operated on nearly thirteen years ago, was for some time most successful. Two years afterwards she reported as follows: "I am much better. The swelling in my neck is scarcely to be seen. The palpitations are better, and my eyes not so prominent. I can walk over ten miles without feeling tired, and take my food well. I work at a machine from 8 a.m. till 8 p.m., dressmaking." But about three months later the patient appeared with a return of the swelling on the left side, eyeballs as prominent as before, shortness of breath, and palpitation of the heart. Since this time I have not seen her. The failure in this case, if it prove to be a failure, is largely due to the unhealthy conditions under which the patient lived. The second patient was under the care of my colleague, Dr. Wheaton, at the Royal Hospital for Children and Women. She made a good recovery from the operation, which took place twelve years ago, with distinct relief to the palpitations and exophthalmos, but I have not been able to learn the later result.

The notes of the third case are as follows:—

Miss M. G., æt. 20, was brought to me by Dr. Taylor, of Acton, in June, 1894, with exophthalmic goitre and the following history. Palpitation and shortness of breath were first noticed six months before, after an attack of influenza. Proptosis and the goitre followed. The enlargement of the thyroid is moderate in amount and uniform. Marked pulsation of the carotids. The usual murmur and thrill over the goitre. Systolic apex murmur. No cardiac hypertrophy. One marked symptom is the fidgettiness, restlessness, and irritability of the patient. There is also a constant short cough. As there is no tracheal stridor and no expectoration, this is probably largely nervous. Pulse-rate, 130-140. Largest circumference of neck over the thyroid gland, fourteen and a quarter inches. Palliative treatment with belladonna, digitalis, and thyroidin tabellæ gave no good result. June 28: Removal of the right half of the thyroid (the larger lobe) and part of the isthmus. The operation presented no special difficulty, save with the isthmus, which was large and lobulated. This was peeled off the trachea up to its junction with the left lobe, transfixed with two sterilised silk interlocking ligatures, and cut away, the stump being pared down to within a safe distance of the ligatures. For the first few days the patient's condition of incessant restlessness, with the consequent tax upon her feeble strength and the disturbance of the wounds, gave rise to much anxiety. Save when under the influence of morphia, the patient was never still for more than a few minutes. She was constantly hawking and trying to expectorate, at one moment on her back, then on one side. She complained greatly of the heat, and as soon as a sheet was drawn over her she would pull it off again. Thanks to Dr. Taylor's watchfulness, the patient made a good though slow recovery; the wound healed in eight days. In June, 1895, Dr. Taylor reported as follows (it will be seen that though there was marked improvement, the operation had not effected a cure):—"Proptosis less marked. Breathlessness better. Palpitation less. Measurement of neck now twelve inches. Patient was able to skate last winter, and can walk ordinary distances."

On April 23, 1900, Dr. Taylor wrote at my request:—"In my opinion the breathlessness is much improved, but the proptosis and palpitation on exertion are still marked. She is quite as restless and excitable as before. Her general health is very good; she is able to walk eight or ten miles at a stretch: the slightest hill, however, produces breathlessness and palpitation."

In the following, my fourth case, there was evidence of auto-intoxication or thyroidin poisoning at the time of the operation, and it would probably have been wiser to have deferred the operation, though I am strongly of opinion that, without operation, life would have closed quickly, and from the same cause, judging from other cases which I have seen in a like condition.

C. D., æt. 25, was sent to me May 13, 1899, by Dr. South, of St. Leonards, with an exophthalmic goitre affecting the whole gland, but especially the right lobe.* The trouble had begun eighteen months ago, and had been steadily continuous in spite of varied treatment. Latterly there had been some interference with respiration, the patient's breath being short on exertion during the day time, and at night there was a feeling of dread of suffocation on lying down. The loudness of the bruit and the distinctness of the thrill and pulsation made it somewhat difficult to be certain, but no tracheal stridor could be made out. The patient's pulse was from 120 to 130, temperature 100°. Her condition was one of great restlessness and agitation. While the above facts made operative interference very risky, prolonged treatment had failed, the swelling was steadily increasing, and with this were already noticed a rising pulse-rate and temperature and increasing restlessness and agitation. If I had sent the patient home, I believe that death would have soon followed with an increase in the above symptoms and cardiac failure. To defer the operation, and keep the patient in a general surgical ward to watch her, would, I consider, have been even more quickly harmful. Operation, in spite of its dangers, gave her a chance.

Her restlessness was certainly not greater than in Dr. A. E. Taylor's case, to which I have referred, a patient of about the same age, who had recovered from the operation. Speaking now with more experience, I doubt if I should operate again on a case in which the pulse-rate, the temperature, and the restlessness were of such anxious omen as in these two cases. If I did operate, I should adopt Mr. Paul's plan, and plug the wound with dry sterilised gauze.

The operation was on May 15. The only difficulty met with was the large size of the isthmus and the firmness with which this and the right lobe were connected to each other and, by dense fascial layers, to the trachea. The junction of isthmus and the right lobe was divided, partly by snipping through with scissors, partly by tearing through with a steel director. The stump left was pared down with scissors. The right lobe was unusually dense and showed no colloid change, and no evidence of any adenoma or cysts. The pulse at the close of the operation was 140, and the same at 10 p.m., when the temperature was 103°. The patient from the time of the passing off of the anæsthetic had been constantly restless, throwing herself about. This condition continued, in spite of treatment, throughout the night and next day. The pulse-rate rose to 160 and 180, and the patient died suddenly from cardiac failure, about twenty-four hours after the operation. At the necropsy the wound looked natural; the only abnormal condition found was the presence of a good deal of sticky mucus in the bronchial tubes.

Having stated my own views on the subject of thyroidectomy, I will next place before my readers other opinions.

Dr. C. A. Mayo, of Rochester, U.S.A., whose name stands so high in abdominal surgery, has recently given his experience of partial thyroidectomy for exophthalmic goitre based upon 40 cases (*Medical Record*, Nov. 5, 1904, p. 734). He has preferred thyroidectomy to operations upon the cervical sympathetic because, "while good results have been thus obtained, these operations show a considerable mortality, and are, moreover, liable to the same disagreeable symptoms which often follow partial thyroidectomy." His rule with regard to operation is to operate if the condition is fair; but if the pulse is from 130 to 160, if it fluctuates in tension or rapidity, if there is anæmia with swelling of the feet, he places his patients on belladonna for some days. In the more severe cases x-ray exposures are continued from two to six weeks. Of the 40 cases operated on 6 died, 1 death occurring on the table, 2 fifteen to eighteen hours, and 3 from twenty-four to seventy-two hours, after operation. Two of these cases, Dr. Mayo points out, should not have been operated upon, owing to the gravity of their condition.

* This enlargement of the isthmus was a marked feature: it reached from the thyroid cartilage to the manubrium. Very distinct thrill and pulsation were noticeable over the swelling, together with a loud rasping bruit.

In the last 25 cases operated on for exophthalmic goitre only 2 died. The fatal cases suffered from an exaggeration of their previous symptoms, the jerking tremor, increasing rapidity of pulse, and exophthalmos. As pointed out by Fenger, degeneration of the heart muscle will account for some of the sudden deaths, while thyroid absorption, shock, anæmia, and general nerve exhaustion will account for most of the other deaths which are not due to the anæsthetic. Dr. Mayo has completed the operation with cocaine in 10 cases; in 2 chloroform was required as well. Cocaine was chosen in the worst cases, especially those with a rapid, fluctuating pulse, but the operator could not see that any difference as to shock or thyroidism existed between local and general anæsthesia. He prefers ether. If mucus accumulates in the air-passages, the patient is allowed to come round sufficiently to cough it up, and then chloroform is substituted. Kocher's collar-incision was employed.

Dr. Mayo's remarks on after-operation thyroidism will be read with interest: "Thyroidism of some degree is common. It is not from rough handling and forcing secretion into the veins. If so, it would be equivalent to hypodermic injection with immediate effect, when in reality it comes on after some hours, and is due, apparently, to absorption of the wound serum with some thyroid secretion in suspension. Thus many of the symptoms of Graves' disease are not uncommon for the first few days following the removal of ordinary colloid cystic goitre. For this reason we drain exophthalmic goitre wounds as freely as we would a septic process. If there is anything which increases absorption in wound or gland, it is loss of blood. Therefore, should the patient lose a quantity of blood, every effort should be made early to replace the quantity lost or more by saline solution."

Albert Kocher has reported (*Mitteilungen aus d. Grenzgebieten d. Med. u. Chir.*, 1902, Bd. ix. Hft. 2) the cases of exophthalmic goitre, 74 in number, which were under his father's care between the years 1883 and 1899. As I have been unable to see the original paper, the following is taken from an editorial article* (*Journ. Amer. Med. Assoc.*, May 23, 1903). Fifty-nine of the 74 cases were operated upon. Four died with symptoms of tetany within ten days of the operation. Of the remaining 55, 39, or about three-fourths of the cases, had unpleasant post-operative symptoms. These consisted of transitory psychic disturbances, irritability, oppression, palpitation, sensation of heat, general tremor, sweating, vomiting, fever, and irregular frequent pulse; in fact, temporary increase in the symptoms present before the operation. The fever and tachycardia persisted in all the 39 cases. The other symptoms mentioned occurred in the majority of the cases. The possibility that these symptoms were due to an acute toxæmia from absorption of certain substances pressed

* The above article claims—extravagantly, as it seems to me—that "Prof. Kocher has conclusively demonstrated that surgical procedures give by far the best results ever obtained in the treatment of this affection." No details whatever are given as to the operative technique employed—it was probably a combination of ligature of the arteries and partial thyroidectomy (p. 704)—or the exact nature and duration of the 76 per cent. of "cures" claimed. While I have been unable to obtain a sight of the original paper I have thought it just to Prof. Kocher to refer to this account, incomplete as it is, of work he has done in this direction.

from the gland during the operation is discussed, but no satisfactory explanation is arrived at. The other 16 patients had no disagreeable after-effects. Forty-five of the cases operated on, or 76 per cent., are stated to have been cured; 8, or 14 per cent., decidedly improved; 2, or 3.5 per cent., were only slightly improved; 4, or 6.7 per cent., died with symptoms of tetany. Necropsies obtained in 3 of the 4 fatal cases showed the following. In the first case there was a persistent thymus, the heart was dilated, there was a fluid exudation in the serous cavities, and the superior cervical ganglion was much enlarged. In the second case death was due to double pneumonia and pleurisy. The fatal result in the third case was believed to be due to the severity of the intoxication, this being confirmed by the dilated heart, the jaundice, and softened liver and spleen.

Dr. Frank Hartley, surgeon to the New York Hospital, in a recent paper (*Annals of Surgery*, July, 1905), takes a favourable view of partial thyroidectomy for exophthalmic goitre. He allows that in several hundred cases the ultimate results have been more or less imperfectly observed. In about 125 cases where observations have been made carefully and in detail at periods varying from six months to twelve years, and where sufficient gland tissue has been removed, he maintains that the pulse rate has fallen within forty-eight hours, and the other symptoms have been relieved within the first week. The exophthalmos may persist for some years. He considers that the symptoms have been best relieved when, in addition to removal of one-half of the gland and the isthmus, part of the opposite lobe has been taken away, or the superior or inferior thyroid artery of the opposite lobe tied. He has used ether or gas and ether always. "An experienced anæsthetist is absolutely necessary, and a very small amount of anæsthetic is to be used." Fifteen cases are given, of which fourteen recovered. These patients, "seen at times varying between one month and seven and a half years following their operation, are in good health, and able to work without discomfort. They have all lost their anxiety and nervousness. Their muscular tremor and, in all but three cases, their exophthalmos have disappeared." The single death in this series was from sudden cyanosis and failure of respiration and pulse during the operation. No necropsy was permitted.

Dr. B. Farquhar Curtis, of New York, gives the later results in fourteen cases of exophthalmic goitre treated by partial thyroidectomy (*Ann. of Surg.*, March, 1906, p. 343). Four cases died from acute thyroidism. All were cases of advanced disease. "Of the ten cases who recovered from operation, one was improved, but has not been seen since. One case was improved for two years, relapsed later, had one artery tied on the other side with improvement, and again relapsed. Eight cases can be claimed as practically cured, having been followed six months (two cases), eighteen months, two years, five years, seven years, eight years, and twelve years. Two of the cases were slight, but the rest were serious and some in a dangerous condition."

In his Bradshaw Lecture on Exophthalmic Goitre and its Treatment (*Lancet*, Nov. 11, 1905), Dr. G. R. Murray is of opinion that the risks of surgical treatment are unfortunately so great that "I do not consider partial thyroidectomy is advisable. I have only seen this operation

performed in two cases, but both patients died within an hour or so."

In support of his suggestion that *x*-ray treatment should be further tried, Dr. Murray quotes the following cases, which are noteworthy: "Beck (*La Sem. Méd.*, July 19, 1905, p. 340), after excision of one lobe of the enlarged thyroid, exposed the other lobe to *x*-rays. In two cases in which this treatment was carried out, in one eighteen and the other three months after the operation, which had only produced an improvement, a remarkable diminution in the nervousness and tachycardia was observed. In a third severe case, in which the *x*-ray treatment was started a week after the operation by a daily exposure of at first five and then ten minutes, the improvement was immediate and rapid. At the end of a week, the treatment was suspended for a week, when it was found that the pulse had fallen from 160 to 180 before the operation to 80, and the exophthalmos had nearly disappeared. After that the *x*-ray treatment was given for five minutes each week. When seen five months after the operation the remaining half of the goitre had disappeared, as had also the exophthalmos and tachycardia. It is, however, difficult to determine whether this satisfactory result is to be attributed to the operation or to the *x*-rays, or both."

As the operation of partial removal of the thyroid has already been fully described, it only remains to refer to one or two details. As I have advised before, if thyroid tabloids have been given, they should be withheld for some days. The most important point is the question of anæsthesia. Where no dyspnoea, tracheal stridor, &c., are present, there are still two dangers to which patients with exophthalmic goitre are especially liable, viz., cardiac collapse and the collection of mucus in the trachea and air-passages. My own experience of local analgesia in cases of bronchocele has been in one case of malignant disease requiring tracheotomy in which a general anæsthetic had to be substituted, and one of a large ordinary bronchocele causing tracheal stridor in which eucaine was used successfully to complete the operation after the skin incision and exposure of the goitre. If a local anæsthetic is employed the operator must not be led into any hurrying of the operation, and thus risk of pulling or squeezing of the parts. A trial of eucaine is, I consider, justified where a surgeon decides only to remove the isthmus, and in a case of an exophthalmic goitre causing dyspnoea in addition to other symptoms. As in all cases of local analgesia, the instruments must be kept out of the patient's sight, a matter of some difficulty here. Personally I should prefer administration of ether or A.C.E. mixture by careful hands, chloroform being substituted as soon as a due degree of stimulation has been reached, eucaine and oxygen being always ready at hand.

While I am doubtful whether the effects of squeezing and handling are as harmful in operations for bronchocele as has been maintained by others, it will be well to be especially careful here, and for the same reason the previous sterilisation should be gently carried out. Any cut or crushed surface left, as after dealing with the isthmus, should be as small as possible. The cautery should never be employed in these cases owing to their poor vitality and the additional risk of infection. The wound is always to be drained. Dr. Mayo's advice about infusion will be remembered, and a patient's condition admits of it, it would be well, especially those increasing rapidly, to follow Dr. 1 superior thyroid vessels on the opposite four cases under the

late v. Mikulicz and Schulz in which a return of the symptoms has been reported after a partial thyroidectomy.

(2) *Removal of the isthmus*.—Where the goitre is very large, the patient's condition so grave as to render it probable that any more radical operation will end fatally, this method may be adopted. It has been described at p. 696. I should be inclined to add, if the condition of the patient admitted of it, ligature of the two superior thyroid vessels, a comparatively easy step with the wound already made.

(3) *Ligature of the thyroid vessels* (p. 707).—It is noteworthy that Prof. Kocher, after all his experience, has come to this conclusion: "In Basedow's disease a combined excision and ligature gives still better results than ligature alone; but excision is often too dangerous, and one is very glad to leave matters alone after ligaturing the three thyroid arteries, which are often dilated." The objection to adopting this step is that, while the superior thyroid vessels are easily found, ligature of the inferior thyroid artery may be extremely difficult (p. 708). It has happened on more than one occasion that it has been found easier to remove half the gland. Owing to the difficulties met with here, ligature of the thyroid vessels may prove a prolonged procedure, thus bringing about the very risks which have been emphasised above.

(4) *Exothyropexy*.—Free division of the deep cervical fascia and displacement of the gland forwards, with its objects, has been alluded to at p. 679. The objections to adopting this step are—(a) Its uncertainty as to the production of atrophy of the gland. (b) The certain risk of infection, however carefully the skin has been sterilised at first. As already pointed out, patients with exophthalmic goitre are subjects ready for infection. (c) Grave sequelæ such as tetany, and those referable to disturbance of the recurrent laryngeal nerve, *e.g.*, dyspnoea and pneumonia have followed the adoption of this step. (d) What is known in the phraseology of the present day as the "cosmetic" result is likely to be bad.

(5) *Removal of the cervical sympathetic*.—This is described at p. 740.

Question of Operation in Cases of Malignant Disease of the Thyroid.—Both sarcomata and carcinomata may be met with; which variety is the more frequent has not yet been definitely determined. Limacher, of Berne, found the proportion to be 44 sarcomata and 38 carcinomata. Both often develop in a gland already affected by goitre, a fact to which I have already alluded. Sarcomata occur in younger subjects. A third variety of malignant disease is the mysterious malignant adenoma, only distinguished by the peculiarity of its metastases, which especially affect the bones, *e.g.*, skull, sternum, &c. These metastases may appear while the thyroid itself appears normal. Further, it may be impossible to detect either in the apparently normal thyroid or the metastases in the bones or lungs any histological difference from normal thyroid tissue (Eiselberg, v. Bergmann's *Surgery*, vol. ii. p. 349). The operative steps here are attempted removal and tracheotomy. With regard to the first, the surgeon must consider here most carefully whether any operation is justifiable. In the first place, the risk of injury to the recurrent laryngeal is much increased from the tendency of a malignant growth to creep round the trachea. The second is the risk of hæmorrhage from the vessels. The third is the risk of the growth spreading to the windpipe. The fourth is the risk of the growth spreading to the trachea. The fifth is the risk of the growth spreading to the lungs. The sixth is the risk of the growth spreading to the bones. The seventh is the risk of the growth spreading to the skin. The eighth is the risk of the growth spreading to the lymphatic system. The ninth is the risk of the growth spreading to the blood. The tenth is the risk of the growth spreading to the other organs of the body.

capsule of the gland and adjacent important parts. Secondly, these growths, especially if rapid, tend to creep down into the anterior mediastinum,* behind the sternum. Thirdly, in addition to these dangers, there must be considered that of glandular invasion—*e.g.*, cervical, mediastinal, bronchial—and the doubtfulness of getting all the growth away, and the increased risks of hæmorrhage and infection.

Mr. Sydney Jones and Mr. Battle published (*St. Thomas's Hosp. Rep.*, vol. xvii. p. 232) an interesting case of sarcoma of the thyroid. The malignancy probably supervened upon previous ordinary enlargement of the gland. It was operated on repeatedly, on the first occasion very extensively, one sterno-mastoid being divided, July 16, 1887. A second operation, Nov. 2, found both the sheath of the carotid and the œsophagus involved. Two months later, tracheotomy was required owing to fresh recurrence. Two further operations were performed in the next three months, and the tracheotomy-tube now not proving long enough, the useful device of securing a piece of large drainage-tube to a full-sized Durham's cannula made the patient comfortable. A little later, April 5, 1888, severe hæmorrhage took place from the common carotid, and two ligatures were applied above and below an opening in this vessel. The patient sank two days later, some dyspnoea having returned at the last. Notwithstanding the rapid recurrence, life was prolonged with comfort by the repeated operations for some months. In the fact that "the local malignancy was great, the general malignancy *nil*," this case of sarcoma contrasts strongly with those of carcinoma.

Dr. Rotter (*Arch. f. Klin. Chir.*, Bd. xxxi. Heft 4; *Year-Book of Treatment*, 1885, p. 138) gives details of fifty cases of malignant disease of the thyroid submitted to operation. Of these eight died in the first twenty-four hours, five at the end of the first week, and eight at the end of the second week. Only four patients remained free from a recurrence at the end of six months. While some of the last thirteen cases may have died from causes more preventible at the present day, these figures point very strongly to the conclusion that in malignant disease of the thyroid attempted removal is most rarely justifiable.

Mr. Berry (2nd ed. of Mr. Butlin's *Operat. Surg. of Malig. Dis.*, p. 216) gives statistics which show clearly that in the vast majority of cases the operation does not result in a cure. Unless performed at a very early stage, before perforation of the capsule, the operation is attended by a high mortality owing to the attempt to remove thoroughly a disease which has involved important structures. Where death has occurred a few days after the operation, secondary deposits have been found at the necropsy in a large number of cases. The diagnosis in the earlier stages is difficult, it being especially hard to say with certainty that the trachea and pharynx are not already involved. With regard to malignancy the chief aids will be early fixity, irregularity of outline, and continuous growth. Mr. Daniel (*Lancet*, July 19, 1902) in an interesting report of four cases of sarcoma of the thyroid points out the tendency of these growths to perforate their capsule posteriorly, and then extend downwards into the thorax. One of the cases was especially deceptive clinically. Even after a free exposure, it appeared as a pale, slightly bossy, circumscribed and encapsuled growth. Though fixed to surrounding parts, it had allowed of up and down movements in

* A remarkable instance of malignant bronchocele is figured by Billroth (*Clin. Surg.*, pl. ii. and iii.). It was a soft carcinoma, and extended down behind the sternum, compressing the right innominate vein, and causing enormous dilatation of the superficial veins of the neck and front of the trunk.

deglutition. Dr. Cumston (*loc. supra cit.*) relates an instructive case of sarcoma bearing on this last point: "The left lobe of the gland had attained the size of an apple; its surface was quite smooth, and it was movable. The skin was normal, and there were no dilated veins. On account of its rapid growth during the preceding ten weeks, a diagnosis of malignant transformation was made, and the growth removed. Microscopical examination showed a typical follicular goitre, the upper part of which had become invaded by a spindle-cell sarcoma in the septa dividing the vesicles of the gland. A focus of sarcomatous tissue was found in the lower part of the gland. The operation was performed in November, 1898, and the patient died of generalised sarcomatosis in April, 1900."

Palliative Tracheotomy in Malignant Bronchocele.—The difficulties and dangers of tracheotomy in operations on bronchocele have been alluded to at pp. 647, 705. Both are increased here. The operation should not be too long deferred. If once suffocative paroxysms have set in, cardiac collapse may occur at any moment. The surgeon must be prepared with long tubes such as that figured at p. 680, or a Durham's cannula with a movable shield and drainage tube attached. In one of Mr. A. Thomson's cases (*vide infra*) this became blocked, and a piece of leaden pipe, such as is used by gasfitters, answered the purpose. If possible the material should be soft, otherwise the tubes are likely to lead to pressure ulceration in the trachea, œdema of the mucous membrane, and effusion of fluid, thus increasing the risk of pneumonia and suffocation. Further there is the risk of ulceration of large vessels, as possibly occurred in Mr. A. Thomson's case given below. The incision must be a free one, even exposing the thyroid notch as a guide. The trachea has often to be recognised by feeling its rings. Where the flattening is antero-posterior, care must be taken not to perforate the posterior wall. Local analgesia (p. 650) should certainly be tried.

Mr. Alexis Thomson (*Edin. Med. Rev.*, April, 1905, p. 363) advocates an attempt to remove as much of the malignant growth as possible in preference to tracheotomy in the dyspnoea of malignant bronchocele. He thus compares the two alternatives before us: "Tracheotomy is always hazardous, and it is not too much to say that it may prove a very difficult or even an impossible undertaking. . . . The second of the two alternatives has the merit of greater certainty and accuracy. The soft parts overlying the goitre are separated, after free division of the integument, by one or other of the incisions usually employed in thyroidectomy. The surgeon then proceeds to the rapid removal of the growth, or as much of it as will free the air passages from pressure. Failing this, the trachea will have been made so accessible that the insertion of an efficient tube is rendered an easy and deliberate undertaking."

A careful study of the instructive cases by which Mr. A. Thomson supports his view proves, I think, that a surgeon facing the dyspnoea of a malignant bronchocele is only justified in preferring partial tracheotomy to tracheotomy under certain conditions. These are the surroundings of skilled help, &c., are favourable, when the trachea cannot be felt or found after a free median incision, or when there is retro-sternal growth that is causing pressure on the trachea.

case in one of Mr. Thomson's patients. The personal equation of the operator's experience has also to be considered. But I do not think that we can go farther than this, and say that partial thyroidectomy is always to be preferred to tracheotomy. In the first of Mr. Thomson's cases, probably a sarcoma, it is clear that the opening in the œsophagus—and it is to be remembered that this happened in experienced hands—might have materially shortened the seven weeks' prolongation of life. Further, the fact that the large vessels may be not only embedded in, but infiltrated and softened by, the growth must be borne in mind. In the second case, which survived three months, the bleeding was "inconsiderable," which is certainly unusual in these cases. It is to be remembered that these remarks are made without in any way criticising the wisdom of the operator in his deciding upon partial thyroidectomy. I only doubt if his cases prove that, even with the skill with which he carried it out, this treatment can be widely used in meeting the dyspnœa of malignant bronchoceles.

Treatment of an Enlarged Thyroid by Ligature of the Arteries.—Prof. Wölfler, who revived this method,* shows (1) that considerable shrinking, with marked relief to the dyspnœa, should follow it, if successful, in a few days, and that there should be no reappearance. (2) Splendid results are here opposed by utter failures. If in the latter cases all the four arteries have been tied, abnormal vessels have, perhaps, existed. On this point he quotes Billroth as to whether the atrophy will be permanent: "If all four arteries have been tied, *yes*; if the circulation is re-established either through one of the principal arteries or through the vasa vasorum, *no*." (3) Experience has shown that ligature of all the four arteries is not followed by gangrene of the thyroid. According to v. Eiselsberg, "this method is frequently associated with recurrences"; others have recorded myxœdema as a consequence.

According to Prof. Kocher, "ligature of the thyroid arteries finds its chief application in the following:—(1) In Basedow's disease. In this affection a combined excision and ligature gives still better results than ligature alone; but excision is often too dangerous, and one is very glad to leave matters alone after ligaturing the three thyroid arteries, which are chiefly dilated. (2) In large vascular colloid tumours, especially of the diffuse kind, where excision is too serious an undertaking, first on account of hæmorrhage, and secondly on account of the sudden loss of a mass of thyroid tissue which, though diseased, was still assisting to maintain an otherwise imperfect function."

These vessels vary so much in situation and course, according to the size and growth of the bronchoceles in different directions, that any dissections for finding them must be uncertain. The chief points to bear in mind are the upper and lower parts of the enlarged lobe: the superior thyroid artery is often rendered superficial by the upper limit of the tumour raising it up. Both vessels may be enlarged and somewhat and thus secondary hæmorrhage may readily occur sterile. The same free incisions as for a quired. On several occasions of late

*! Treatment of Goitre, p. 438.

years in dealing with large goîtres causing dyspnœa, after removal of one half and the isthmus, I have, when uncertain as to the relief of pressure on the trachea, tied the opposite superior thyroid vessels, with good results.

Ligature of the Superior Thyroid Artery.

RELATIONS.—This vessel, the first branch of the external carotid, arises just above the bifurcation, about a quarter of an inch below the great cornu of the hyoid. At first, covered only by thin fasciæ and the platysma, it ascends slightly, and then curves downwards with a tortuous course, covered by the depressors of the hyoid bone and the sterno-thyroid.

Operation.—The patient's head being suitably raised, and turned to the opposite side, an incision, about two inches long, is made along the inner border of the sterno-mastoid, with its centre corresponding to the upper border of the thyroid cartilage. The superficial parts being divided, the sterno-mastoid and the large vessels are drawn outwards, and the omo-hyoid downwards and inwards, or this may be divided. The artery is then searched for with the point of a steel director in the hollow between the larynx and the carotid. Some enlarged veins, belonging to the superior thyroid, will probably require division after the application of double ligatures.

Ligature of the Inferior Thyroid Artery.—This operation is a good deal more difficult, owing to the depth of the vessel and its more important relations.

RELATIONS.—The artery, the largest branch of the thyroid axis, ascends tortuously inwards behind the carotid sheath, the middle cervical ganglion and its branches lying in front of it. Before entering the gland it lies for a little distance in relation with its posterior surface, and in this part of its course the recurrent laryngeal is in close contact with it.

GUIDE.—The carotid tubercle of Chassaignac, or the transverse process of the sixth cervical vertebra. Sir W. MacCormac gives the body of the fifth cervical vertebra, opposite to which the artery enters the thyroid gland. The common carotid is also a guide.

Operation.—An incision, three inches long, having been made along the anterior border of the sterno-mastoid coming down to the clavicle, as if for ligature of the carotid low down, the deep fascia is opened and the sterno-mastoid and the structures in the carotid sheath drawn outwards. The head being now flexed to relax the parts, the goître is raised and displaced inwards, the carotid tubercle is felt for, and the artery sought for below it, by carefully working here with a director. If these steps have failed to find the artery, the method of C. M. Langenbeck (v. Eiselsberg) should be followed. The sterno-mastoid, the large vessels and nerves, are drawn to the middle line, and the anterior scalene sought for, which may be recognised by the phrenic nerve crossing it. The artery will be found running diagonally upwards and inwards at the inner margin of this muscle after raising the goître. The vessel should be exposed and the ligature applied*

* According to Billroth and Wölfler, this artery is often friable, and thus easily torn, this condition being perhaps due to fatty degeneration from pressure of the bronchocele.

as far from the thyroid gland as possible, so as to avoid injury to the recurrent laryngeal, which, as above stated, crosses over the trunk or ascends among the branches of the inferior thyroid. The neighbourhood of other important structures—*e.g.*, the phrenic nerve and, on the left side, the œsophagus and thoracic duct—must be remembered.

Treatment of Thyroid Cysts (Fig. 257).—These are sometimes of much importance owing to their size, their important relations, and, as shown by Mr. Clutton's case below, their occasional vascularity.

The best treatment is excision whenever this is practicable; with much larger and older ones, a safer one may be incision and drainage. Injection with iron perchloride has given some good results, but there is always the risk of suppuration and cellulitis in a very dangerous region owing to the presence of the larynx above, the mediastinum below, and of numerous veins, these being liable to puncture, and thus to immediately fatal thrombosis, or, later on, to infective phlebitis. This method is certain to fail in thick-walled cysts, or in multilocular cases.

Where the cyst is moderate in size and not of very long duration, it should always be excised; and the case given below shows that this may sometimes be practised where the cyst is huge in size and of long duration. The cyst, if not previously submitted to futile blistering, &c., usually turns out easily. If it will give more room the cyst may be slit up, and its contents evacuated, when, by seizing first one cut edge and then the other, it is turned out in a collapsed and empty state. In either case, great care must be taken to work with a pair of blunt-pointed curved scissors (p. 691). After removal of cysts of any size the remains of the thyroid lobe from which the cyst is shelled out looks collapsed and useless. It should not be removed, however. The wound cavity should be obliterated by carefully applied pressure (p. 693). Where much thyroid substance is left lacerated, it would be well to fill the wound for a few days with dry sterilised gauze (pp. 685, 694).

The above remarks apply to single cysts. Mr. Clutton (*St. Thomas's Hosp. Rep.*, vol. xvi. p. 173) has pointed out that where there are many cysts, or where a cyst is combined with much disease, the whole half of the thyroid affected had better be removed.

Where excision is impossible—a rare condition—the method of incision is usually very simple. The soft parts having been duly sterilised, an incision is made through them down to the cyst, and any bleeding points secured. The cyst is then slit open and its interior examined. This may vary considerably both as to thickness and contents, and vascularity of lining membrane. Thus the contents may be a serous, mucoid, gelatinous, or grumous material, or coagulated blood-clot. The amount of vascularity is of two-fold importance: if of very long standing the cyst-wall may be so fibrous and evascular that sloughing of it may readily take place, especially if the wound becomes infected. On the other hand, it may be extremely vascular (Clutton, *loc. supra cit.*), in which case such abundant hæmorrhage will take place as to leave no time for suturing, and require immediate plugging with aseptic gauze.

Knowing how tedious these cases are in granulating from the bottom

and becoming completely obliterated, I prefer, in the few cases where excision is impossible, to suture the cut edge of the cyst to the surrounding margin of the skin, and then, with a sharp spoon, to curette the lining membrane, thus promoting the closing of the cavity from the bottom. The cavity is then lightly plugged with strips of sterilised gauze, and the dressings applied. But this method, by failing to secure primary union, is more tedious than that of excision. Mr. Bowlby's case of retro-sternal cyst (p. 681) shows how it may be successfully employed.

I would again draw attention to the very important fact that in these, as in all other thyroid cases (and in many others) where primary union

FIG. 257.



is not secured, silk ligatures or buried sutures, if many of these have been used, may continue to come away for a very prolonged period. The cyst quickly falls in and puckers together, but a sinus is liable to persist through which ligatures are long discharged. Thus, in one of Mr. Clutton's cases a sinus persisted for two years, and then quickly closed; in another the patient was still wearing a drainage-tube a year after the operation.

As bearing on the treatment of thyroid cysts by excision, and as a good example of one of the complications which may follow operations on the thyroid gland, I may now mention the following case (Fig. 257):

A gentleman, aged 55, was sent to me, towards the close of 1885, by Mr. Cooper Forster, with a right-sided thyroid cyst, almost colossal in size, and reaching from the ear to below the clavicle, and outwards into the posterior triangle. The trachea was

under the edge of the left sterno-mastoid. The swelling was first noticed twenty-six years before, being then about the size of a hazel-nut. About nineteen years before, owing to some dyspnoea, the swelling was tapped by Mr. Forster; gradually refilling and increasing in size, it was tapped by myself in 1885, the fluid being thick with material resembling Parmesan cheese. As the cyst quickly refilled, I proposed free incision and drainage, and sought first the opinion of my old friend, Mr. Durham. As, in spite of twenty-six years' history, the cyst had a certain distinct, though limited, amount of mobility, Mr. Durham advised extirpation in preference to incision. This counsel I accordingly followed. Ether was taken very badly, especially at first. An incision being made from the angle of the jaw to the right sterno-clavicular articulation, the sterno-mastoid was found spread out over the cyst and adherent to it, perhaps from the previous tappings. As the patient was breathing very badly, no time was spent in separating the muscle, but the cyst was reached by cutting away the adherent part. The superior thyroid vessels being found and tied, the cyst was turned downwards out of its bed, partly with the finger, partly with a blunt dissector; a vessel in the position of the middle thyroid vein was found, and a small vessel below where the inferior thyroid was expected. The chief attachment of the cyst was in the middle line, where it was connected with the isthmus (not itself enlarged) by a fairly fleshy pedicle. This was separated from the trachea and tied in three pieces, partly with the aid of a steel director, partly with an aneurysm-needle. About fourteen carbolised silk ligatures were used, and strict antiseptic precautions were taken throughout, including the use of the spray. An enormous cavity remained when the cyst was shelled out, exposing the common carotid and its bifurcation, the larynx, trachea, and œsophagus; but, though a strong light was thrown into the bottom with a mirror, nothing could be seen of any injury to the gullet or of the recurrent laryngeal. Special care was taken to verify this, as towards the close of the operation (which lasted twenty-five minutes) there was some vomiting of coffee-grounds stuff, streaked here and there with brightish blood.

No dyspnoea and no lividity had been noticed during the operation, beyond the difficulty which had from the first accompanied the anæsthetic. As the effects of the ether subsided, a peculiar stridor was found to accompany the breathing, being much more marked in inspiration. The voice was not affected, beyond being weak, and there was no lividity. The stridor, but without marked dyspnoea, went on increasing for about two hours, the patient being much alarmed from dreaded "choking." Though he vowed that he could not swallow owing to the above alarm and from the feeling of soreness, "like a bone in the throat," he was persuaded to take a dose of potassium bromide, and passed a fairly good night. The next day was a comfortable one, and the breathing, which was twenty in the minute, was much easier, and perfectly so while the patient slept. The next two days were very anxious ones, the stridor returning, with great restlessness and distress on account of paroxysmal attacks of dyspnoea. Accompanying these a condition of quiet delirium set in. The respirations ran up to 40, the pulse to 140, while the temperature remained 99°. The wound was now, and throughout, perfectly sweet. As there was some carboloria (without albumen), the drainage-tubes were syringed out with boracic acid, and iodoform gauze dressings applied as before. The pulse was of grave omen, about every ten or twelve beats dropping, fluttering, and then, as it were, staggering on, to intermit again in another ten beats. This, Dr. Goodhart thought, might be due to some chloral that had been given at night.

The diagnosis now was doubtful—whether one of injury to the recurrent laryngeal, or one of œdema glottidis. Mr. Durham, who inclined to the latter view, advised the use of warm, moist boracic acid lint dressings, and inhalations of steam and terebene.

The breathing gradually became less laborious and noisy, and the power of swallowing quickly returned. Recovery was retarded by a succession of fogs and some localised pneumonia, which, giving anxiety at first, entirely cleared up under Dr. Goodhart's hands. When the patient left town, six weeks after the operation, there was no difficulty in swallowing; the stridor was only noticed on deep respiration, or during quick or prolonged talking. The wound was now represented by a sinus at the lower end; all the rest was well healed. The failure to secure primary union was largely due to the great restlessness of the patient two days after the operation. Ligatures continued to come away for nine months, when the wound healed at once. When the patient was last seen,

four years after the operation, there was still a very little stridor* on deep breathing or rapid talking, and the voice was still a little husky, but the patient was able to follow his employment actively, and to get quickly over hilly ground.†

While the diagnosis here remains obscure,‡ I am of opinion that (1) the restlessness and distress were due to absorption of thyroid secretion (pp. 685, 701); (2) that, with the bloody vomit in the course of the operation, and the great dysphagia afterwards, although the huge cyst turned out so quickly, some slight injury was probably inflicted on the œsophagus, with stretching or embedding in inflammatory effusion of the right recurrent laryngeal.

While dealing with operations on the thyroid, I will refer to an associated condition, rare, but of much importance.

Operation for Lingual Goitre or Accessory Thyroid at the Base of the Tongue, or for a Dermoid Cyst in the same Situation.—The operation here must be either through the mouth or by the trans-hyoid route (p. 618). In making his choice the surgeon must not attach too much importance to the fact that accessory thyroids of the tongue usually occur in female patients, and that the intra-oral operation leaves no external scar. He must remember the position of the growth far back close to the aperture of the larynx, the vascularity of the region, and the need of total enucleation, otherwise persistence of the trouble is certain. I advise the trans-hyoid route for both the affections mentioned above; but my experience is limited to dermoids. This route, in my opinion, gives better access, is farther removed from the orifice of the larynx, gives far better drainage, and the median scar left is not a disfiguring one.

The intra-oral route may be preferred by some when the mouth is large, the tongue slim and not bulky, and where the growth projects well on to the dorsum of the tongue (Storrs *Annals of Surgery* (1904), p. 323). All hæmorrhage must be arrested absolutely, owing to the position of the wound, and this should be partly closed with sterilised catgut. A preliminary laryngotomy, a step of the usefulness of which I have spoken at pp. 614 and 624, and a tampon, secured with silk, placed low down over the opening of the larynx, will prevent blood getting into the air passages, but will interfere with the mobility of the base of the tongue.

* The stridor here and in other cases where certainly no damage has been done to the recurrent laryngeal nerve may have been due, in the first place, to the altered relations and want of support of the much-displaced trachea; its long continuance, in a very minor degree, to contraction of the scar tissue.

† A year after the operation he wrote thus: "I have not been so strong and active for many years. The other day I went in the morning to London, to the Academy, Grosvenor, 'Alice in Wonderland,' Fitzroy House, then to a council meeting of the Photographic Society, and home. There was a damp fog all day, and I am not the worse for it."

‡ Owing to a projection of the incisor teeth, and a life-long difficulty in opening the mouth widely, it was found impossible—Mr. Durham and Dr. Goodhart also trying—to get a view of this patient's larynx.

CHAPTER XIV.

REMOVAL OF LARGE DEEP-SEATED GROWTHS IN THE NECK.*

BEFORE deciding to undertake the removal of one of these, the surgeon should consider carefully the following points :

- A. The nature and surroundings of the growth.
- B. His operative skill in these cases, and his knowledge of anatomy.
- C. His experience in aseptic surgery, and in keeping a large wound sterile.

The chief growths which call for a decision are the following: The (rarely met with) more innocent ones—*e.g.*, enchondromata, fibromata, glandular tumours, including the tuberculous; sarcomata, very likely cystic, originating in the neck apart from the cervical glands; sarcomata of the glands; and carcinomata of the glands secondary to epithelioma of the tongue, lip (p. 603), &c.

Of the three points above mentioned, it will only be needful to consider separately the first; the importance of the two others will be sufficiently shown in the remarks on the operation and after-treatment.

A. **The Nature and Surroundings of the Growth.**†—In examining into these, careful attention should be paid to the following: *Duration*; *rate of increase*; *amount of fixity*. How far this last was early established, and how far it is absolute, are of the utmost importance. The gravest cause of fixity is, of course, a growth with a wide base, or numerous root-like processes extending into important parts. The fixity should be tested by seeing how far the finger-tips can be insinuated beneath the growth, how far it can be lifted up, and the amount of its connection to parts such as the jaw and larynx, the head being steadied by an assistant while the growth is lifted up and its deep processes put on the stretch as much as possible. *The outline*: Is this well marked or indistinct, and, if the latter, is it in dangerous regions, such as the parotid, the zygomatic, and other fossæ, that the growth is lost? *Its relation to important structures, and the degree to which it blends with them*: Thus, any evidence of pressure on vessels and nerves, trachea and pharynx, &c., should be carefully looked for—*e.g.*, weakness of the temporal pulse, engorgement of veins above, alteration of pupil,

* Growths of the tonsil are considered at p. 608, bronchoceles at p. 677.

† The reader should also consult Mr. Holmes's remarks on these cases (*Syst. of Surg.*, vol. viii. p. 886), a paper by Mr. Barker (*Lancet*, 1886, vol. i. p. 194), and one by Mr. Jessett, illustrated by some admirable photographs (*Brit. Med. Journ.*, 1886, vol. ii. p. 712). Mr. Holmes quotes Langenbeck (*Arch. f. Klin. Chir.*, Bd. i. Heft 4, S. 14) as pointing out that, in tumours which involve the sheath of the vessels, engorgement of the veins of the face is rarely absent.

numbness of upper limb,* dyspnœa, or dysphagia. Does the growth dip near or into the thorax? How far under the sterno-mastoid does it go? Are the glands enlarged as well? Is the skin involved? This last point, together with fixity, indistinctness of outline, rapid growth, softness, and fusion with surrounding parts, is of chief importance, and, if co-existing to any extent, will usually put any operation out of the question.

Main Points in the Operation itself.

i. **Free Exposure of the Growth.**—The incisions should be sufficient, the flaps turned back, V, Γ, or X in shape. Thus, if the growth be in the anterior triangle, not encroaching on the posterior, a V-shaped flap with the base upwards, one limb along the sterno-mastoid and the apex above the sternum, may be employed, or one with the long limb inside the entire length of above-mentioned muscle, and another at right angles to it at the level of the thyroid cartilage, curving upwards towards the chin. If the growth invade both triangles, and it be necessary to divide the sterno-mastoid, an incision obliquely across both triangles, and over the muscle, from mastoid process to sternum, and then a second to make it crucial, will be the best. Where it is not needful to divide the muscle the incision going by the name of Dr. Beatson, of Glasgow, will be sufficient and leave a less noticeable scar. It begins in the submaxillary region near the angle of the jaw, is carried outwards across the sterno-mastoid and the posterior triangle as far as the anterior border of the trapezius. It is then carried down the anterior border of this muscle as far as the clavicle and then forwards over the sterno-mastoid, again to end at the sterno-clavicular joint. The large flap is turned forwards, and access thus gained to both triangles. It is always to be remembered that inadequate exposure of the tumour will lead to groping in the dark, bruising of the soft parts, and injury to important structures.

ii. **Deeper Dissection.**—In this attention must be paid to—

(a) Working as much as possible with a dissector, Kocher's elevator (p. 691), or using blunt-pointed scissors partly to cut with and partly closed as a blunt dissector, and keeping the instrument used close to the growth. The dissection should be begun either where the growth is most free, and where its relations are not important, or by at once identifying the most important structures, *e.g.* the carotid sheath and internal jugular vein.

(β) Clamping or tying with sterilised ligatures every vessel before it is divided, not only to minimise the loss of blood, but also to avoid the risk of air entering the veins, especially low down in the neck.

(γ) Of the important structures to be remembered several are alluded to in the next section. Others must be remembered.

Injury to the vagus on one side.—Accidental ligature or clamping of this nerve has been followed by perilous interference with respiration and the heart's action. Division or resection of the trunk below the origin of the superior laryngeal nerve will lead to hoarse, diminished

* Growths springing from the lower vertebræ or the first rib may interfere with the nerves and vessels of the arm. Such a case was brought before the Medico-Chirurgical Society, Jan. 12, 1886, by Dr. Bruce and Mr. Bellamy. See an instructive paper on cervical ribs by Mr. Gordon, of Dublin (*Brit. Med. Journ.*, June 8, 1901).

voice from paralysis of the recurrent laryngeal branch, while after injury higher up, in addition to these laryngeal symptoms, there will be diminished sensation of the mucous membrane of the larynx. While not of itself immediately fatal, injury to the vagus is a serious addition to the dangers which a patient, usually of diminished vitality, and often advanced in years, has to pass through after a prolonged operation for the removal of a large growth of the neck.

Mr. Godlee (*Clin. Soc. Trans.*, vol. xix. p. 321) showed a child in whom, during the removal of a deep-seated growth, the nature of which was doubtful and which was pressing upon the pharynx, the cervical sympathetic had been wounded. The only results were, that the pupil on that side was smaller but not stationary, and that the ocular slit was also smaller.

Wounds of the Thoracic Duct.—In the extirpation of deep tuberculous or malignant glands, especially if adherent and breaking down, extirpation of malignant growths, in ligature of the first part of the left subclavian artery, this complication has been several times recorded. Its occurrence may be discovered at once, the surgeon seeing fluid like watered milk issuing from the depths of the wound; the first intimation may be given a few hours after the operation by the dressings being found soaked; or several days later, the wound having healed superficially, a large fluctuating swelling may appear, on opening which a similar fluid escapes. If the wound is a partial one lateral ligature or suture with very fine silk or catgut is the ideal treatment. Deanesley (*Lancet*, ii. 1903) transplanted the severed duct into the wall of the vein. If the injury be complete, the distal end of the duct should be ligatured, but these steps are difficult and liable to failure. The treatment best adapted to the largest number of cases is pressure by a graduated tampon at the root of the neck, the wound having been first carefully sutured without drainage, if possible. The prognosis in these days is good. Even in those cases where the discharge has been profuse and loss of flesh has been rapid, recovery has usually followed. In some cases this favourable result has been due to the main duct subdividing before its termination.

(δ) If possible, the growth-capsule, which is often soft and delicate, must not be ruptured. On examining the growth after removal, the capsule should not only be entire, but any process should be blunt and rounded, not soft and ragged as if torn away from parts left behind.

If the surgeon feel doubtful as to any portion being left, as in the fossæ about the base of the skull, he should use a sharp spoon and Paquelin's cautery, or pack in lint with a paste of equal parts of zinc chloride and flour (p. 434), or, better perhaps, use formalin (pp. 436, 451).

(ε) Throughout these operations, which may necessarily be prolonged and attended with loss of blood, and in which important parts may be disturbed and pulled upon, the surgeon should keep himself informed as to the effects of the anæsthetic.

iii. *Closure of the Wound and Application of Dressings.*—After completely removing the growth and any outlying glands, the resulting cavities are thoroughly dried out, and drainage provided in accordance with the position which the patient will occupy. Tubes of sufficient size being in position, the wound is brought together and the dressings applied with the precautions already given at p. 693.

Operative Treatment of Tuberculous Glands.—This may be given here owing to the greater frequency and importance of this disease in the neck. *Question of Operative Interference.*—The following abundantly justify something more vigorous than mere palliative treatment: (1) The fact that one gland has power to infect others, even when the local starting-point may have been cured, though too late to prevent extension. (2) The disease, if merely palliated, is often extremely tedious, keeping the patient from the enjoyment and activity of some of the best years of life. (3) The scars which follow on a natural cure are far more disfiguring and extensive than those after a well-planned operation, especially one in which primary union has been secured by strict aseptic precautions, and by operating before caseation and suppuration have altered the normal condition of the parts. (4) The long years a natural cure requires; the repeated suppurations and the blighted days cause grave deterioration of the general health, which may persist for life, long after local cure has taken place. (5) The poor vitality thus induced, and the actual presence of the tubercle bacillus, render the patient very liable to such diseases as phthisis. (6) The chief indication for operation is persistence of the disease, and the slightest evidence of commencing caseation. (7) There are a few and very occasional cases in which operation is to be deferred or avoided. I refer to those where (α) there is advanced disease elsewhere, and (β) where there is threatening of a general outbreak. Here the temperature will be a valuable guide. (8) In advising operative steps in tuberculous glands of the neck, any thoroughly qualified surgeon is justified in impressing on the friends (α) that the treatment of the case will be shortened; (β) that convalescence be will hastened; (γ) the result will be more permanent; (δ) if it be performed early, less of an operation will be required.

The chief groups of glands must be remembered. (1) The parotid or pre-auricular. Some of these are embedded in the salivary gland. While the greater part of the pes anserinus will be protected by a sufficient layer of salivary gland tissue, its proximity is not to be forgotten, and most operators will keep exceedingly close to the capsule of the diseased gland, and, if it be adherent, "scrape rather than dissect" (Sutcliffe). (2) Posterior auricular. (3) Sub-occipital. (4) Submaxillary. Some of the deepest of these lie in the folds of the submaxillary salivary gland. This structure should be extirpated in all doubtful cases. (5) Submental, a small group often overlooked. (6) Superficial cervical. A group running with the external jugular superficial to the sterno-mastoid, and along its posterior border. When these are adherent the presence of the spinal accessory coming out into the posterior triangle must be remembered. (7) Deep cervical, lying along the carotid sheath. Their relation to the large veins is alluded to below. (8) Glands in the posterior triangle, continuous with the superficial cervical above and (9) the supraclavicular below. If these last have become affected, extension to the glands in the axilla is extremely probable. (10) The suprasternal gland in Burns's space. (11) The retro-pharyngeal group.

By far the best is (A) Excision. (B) Curetting or scooping out the glands is very inferior, and only to be made use of on a few occasions.

(A) **Excision.**—*General Principles to be Remembered.* These refer chiefly to advanced cases.—i. Antedate, if possible, caseation and suppuration. If these have been allowed to run on before an operation is permitted, the parts will be matted, adherent, altered; relations will be difficult, perhaps impossible, to make out; important structures, such as the internal jugular vein, will easily be damaged; primary union will be rarely secured, and the scar will, therefore, be needlessly prominent. Where one or more glands are softening, opening the abscess and thorough curetting may suffice; but as a rule a sinus is left, and fresh glands appear. If the surroundings are favourable the suppurating area may be removed through a free incision. As a rule, it is best to open the abscess, and, two or three weeks later, to deal with its remains together with the rest of the disease. Where a sinus is present this should be first curetted and sterilised, as far as possible, with pure carbolic acid. At the time of the operation sterilisation should be thorough, the hair shaved, and kept out of the way with prepared towels. ii. Wherever possible, the incision should be placed along some natural crease or in some sulcus, so that the scar shall be less noticeable. But (iii.) the incision must always be sufficiently free. The scar will be little larger, and much handling through a small incision forbids primary union. Moreover, a free incision enables the operator, in cases where caseation has already taken place, to find one or more spots where the anatomy is normal, and where he can start with important relations, *e.g.*, the internal jugular vein, easily recognised. Transverse incisions following like folds leave less disfiguring scars, and should be employed in slighter cases. But this fear of scars can be overdone. The too wide adoption of transverse scars will certainly defeat its object by leading to repeated operations. While I admit that longitudinal wounds may leave thicker scars, and ones more liable to be keloid, there are other conditions in their production which must be remembered. It is the more advanced cases which call for free incisions; patients or their friends, by postponing the operation on account of the fear of scars, are often largely responsible for the conditions which these incisions have to meet; finally, in some cases deficiency in the technique of the operation must bear some of the responsibility. Several incisions have already been mentioned (p. 714); the two chiefly useful are one along the cervico-submaxillary crease and another along the anterior border of the sterno-mastoid. In extensive cases it is always well to begin the deeper work below where the anatomy is usually normal; to define the internal jugular vein here and work upwards at first. The flaps must be raised carefully, owing to superficial glands being often affected, and which must not be cut into. Any infected skin or disfiguring scars should be left to be removed with the subjacent glandular areas. The flaps when raised are to be wrapped in sterile gauze. Especial care must be taken with the upper one that it is not infected by the manipulations of the anæsthetist, or by saliva from the mouth. iv. The chief structures to be remembered are (a) the internal jugular vein. As in all operations on the neck where this is likely to be involved, the first point is to define it. This, for the reason already given, is best done below. The edge of the sterno-mastoid having been defined, the deeper layer of deep fascia is incised here, the sheath opened, and the vein well exposed. By working upwards

towards the more affected area the glands can usually be peeled off from the vessel by insinuating a Watson Cheyne's dissector, the closed ends of blunt-pointed curved scissors, or an elevator such as Kocher's (p. 691). The forceps which I have found most useful are the old-fashioned tongue-forceps; more recent forms are those which bear the name of Cumming, Kocher, Lane, and Sutcliffe's modification of the last mentioned (Down Brothers). Frequently, when the glands seem quite adherent, careful, patient working is successful in leaving the vessel unopened. Where the glands are too adherent to admit of this and the vein is opened, the opening, caught with Spencer Well's forceps, may be tied up, or sutured laterally with fine silk. To admit of this being done a sufficient area of the vessel must be exposed to allow of pressure being made on it above. Where these steps are not available, where the anæsthetic is causing anxiety, or where a gland has ruptured and part remains adherent, the vein should be resected between double ligatures securely applied. But this step is not to be as lightly undertaken here as in the removal of epitheliomatous glands. I admit the force of the reasoning of those who advise resection of the internal jugular, *e.g.*, Mr. Stiles and Mr. Watson Cheyne, that it greatly facilitates extirpation of the glands. I am more than doubtful whether it is correct to rely on the statement, "The loss of the vein apparently makes no difference to the patient." I am strongly of opinion that this step is not to be adopted as a matter of routine, as one of the improvements of modern surgery. Those who have seen much of these cases know that, in children especially, it is not very unusual for tuberculous cervical glands to be bilateral. Let us suppose that the internal jugular has been resected on one side. A little later like mischief appears on the opposite side; and a surgeon holding advanced views adopts the same step on this side also. The effect of this on the intracranial circulation of the child might be instructive; it would scarcely be harmless.

(β) The spinal accessory is often embedded in a mass of glands,* and I would take this opportunity of saying that where the posterior and the anterior triangles both contain tuberculous glands they should be operated upon on different occasions. The nerve should be defined where it enters the sterno-mastoid at a point which is about opposite to the angle of the jaw, the upper part of the sterno-mastoid freed by dissection and drawn inwards, the point of exit of the nerve into the posterior triangle next found, and a probe passed downwards and outwards along its course as a landmark. In the posterior triangle it is easy to mistake one of the descending branches of the cervical plexus for the spinal accessory. Division of the sterno-mastoid, always permissible in the removal of epitheliomatous glands, is rarely needed now, if the muscle is well retracted first to one side and then to the other. If division of the muscle is really needful, the point chosen should be below that of entrance and exit of the spinal accessory. "If the case heals primarily a good muscle results, but usually it is for the removal of extensive adherent broken-down nodes that its section is necessary, and these are just the cases which heal slowly and leave a depression at the point of healing. The writer has never seen

* This, therefore, is one of the few occasions on which the operator must depart from the rule of removing infected glandular areas as far as possible *en masse*.

disability or torticollis follow its division" (Dowd). (γ) The position of the phrenic nerve on the scalenus anticus is always quite easy to identify. (δ) The inframandibular branch of the facial is frequently divided in clearing out the submaxillary group. Some weakness of the lower lip follows, but disappears in about six weeks. The patient or friends should be prepared for this.* The possibility of injury to the thoracic duct has been referred to at p. 715. In operations low down in the neck the risk of entrance of air into the veins is always present; if this accident should occur the wound should always be flooded with sterile saline solution before artificial respiration is resorted to, and in this region, to avoid dangerous hæmorrhage, every vessel should be secured before it is divided, otherwise it may retract out of reach. v. Each group of glands should be removed, as far as possible, *en masse*. vi. Tuberculous mischief is to be dealt with, here as elsewhere, as if it were malignant, and all diseased tissues eradicated as if this, the first opportunity, were going to be the last. vii. Careful asepsis must be maintained throughout. viii. In all doubtful cases drainage is to be employed. Thus a tube should always be employed in cases where a caseating gland has ruptured during removal, and may have infected the wound in spite of careful swabbing out with pure carbolic acid and irrigation. Again, where the cavity is a large one, of uneven base, with many pockets or recesses, where much oozing is present, a drainage-tube should be employed for two or three days. All surgeons of experience must be familiar with cases where, after securing primary union, the swelling has soon reappeared, and, on opening up the diseased area, structures which at the first operation, *e.g.*, part of the sterno-mastoid, digastric, &c., were absolutely healthy are now covered with greyish granulation tissue, the structures being now only recognisable by their position and outline. Another result of infection of the wound by tuberculous material left behind is rapid breaking down of the scar, not a reappearing swelling. The risk which the drainage-tube entails of infection from outside can be met by careful dressing and regular resterilisation of the adjacent skin during the time that it is needful to retain the tube. From my experience, the risk of reinfection after complete suture of the wound is much the greater of the two. ix. Pressure is always to be well applied, for the same reasons and in the same way as given at p. 693. But where there is any doubt about the wound being sterile, boracic acid fomentations should be used at first. x. Sufficient rest of the parts is most essential here. Sir F. Treves has insisted on this point in the after-treatment. It is one of very great importance, if a small and sound scar, and obliteration of any tubercular material possibly left behind, are to be secured. The patient should rest absolutely in bed for the first fortnight. Poroplastic jackets holding up efficiently the chin and occiput are most useful when the wound is healed. When the parts are

* Dr. Dowd, of New York (*Ann. of Surg.*, July, 1905), gives rules for avoiding this nerve. The chief are that, as the nerve runs just below the mandible and lies between the platysma and deep fascia, the skin incision should be made an inch below the bone, and the muscle and deep fascia should be divided a little below the level of the skin incision; they should then be retracted upwards with the filament between them.

thus kept at rest, the child should live out of doors in the best air available. xi. The patient is to be kept for a long time under observation, owing to the risk of persistence and reappearance of the disease. Nowhere do the wise words of Verneuil find better application, that in dealing with the tuberculous we must be prepared for "half successes, incomplete results, and unfinished cures." A wise surgeon, when an advanced case is brought to him, will do well to undertake only his fair share of responsibility for the result. The patient or the friends must be prepared for more than one operation.

(B) *Curetting or Scooping out the Glands.*—While its value has been clearly proved in the instructive papers on "Scrofulous Neck and the Surgery of Scrofulous Glands," put forth by Dr. Allbutt and Mr. Teale as clinical lectures at the Leeds School, from which so much good surgery has already come, it is very inferior to aseptic treatment by excision, for the reasons I give below. The following are Mr. Teale's conclusions as to the surgical treatment of these cases:—(1) That surgery can secure the healing in a very few weeks* of gland cavities and sinuses, even though they have existed for years. (2) That, in dealing with sinuses, gland abscesses, and decayed or semi-decayed lymphatic glands, the action of the surgeon must be vigorous and thorough. (3) That the visible abscess, which should often be called, and treated as, a tuberculous suppurating gland, is, as a rule, merely a subcutaneous reservoir of pus, its source, a degenerate gland, being *not subcutaneous*, but *sub-fascial*, i.e., under the deep cervical fascia, and sometimes even sub-muscular, the communication between the two being a small opening just large enough to admit a probe or director. (4) That it is utterly futile merely to incise or puncture such a subcutaneous abscess dependent upon a degenerate gland which lies beneath the deep fascia. (5) That when a damaged or suppurating gland has been got rid of before the overlying skin is thinned by advancing suppuration the resulting scar is insignificant and not an eyesore. (6) That, in dealing with a sinus, the channel should be enlarged by the knife or a "Bigelow's dilator," and the whole of its granulating surface scraped out. Where the skin is thin and blue, this should be scraped away, and any cutaneous overhanging edges trimmed off with scissors. (7) That, in dealing with a sinus or an abscess, the surgeon should not rest content until he has discovered and eradicated the gland, always remembering that, if it be not obvious, there is sure to be a small track leading to it through the deep fascia. This should be enlarged so as to admit a sharp spoon. (8) That, when a gland has suppurated or become caseous, the capsule should be freely opened and the contents scraped out. This is sometimes easy, the enucleation leaving the stiff capsular case virtually cleaned out. Sometimes it is very difficult to get rid, even by the most vigorous scraping, of a tough living stump of gland firmly adherent to the capsule. It is well to dissect this remnant away with a scalpel, if the risk of injuring important structures be not too great. (9) That sometimes, when such an empty capsule is left, the finger detects in its wall a bulging contiguous gland. This should be punctured through the wall of the cavity, and so reached and enucleated. In this way, in more than one instance, Mr. Teale has emptied from one external opening a group of three or four glands, suppurating or broken down.

I consider the above method much inferior to that of aseptic excision, for the following reasons:—(a) It is limited to cases where one or two glands are involved. Cases such as these form a small minority of tuberculous cervical glands. (b) It deals only with caseating and suppurating glands. (c) In the majority of cases there are glands, often numerous, which are infected and which will certainly give trouble, though not as yet softened. Such can only be removed by a sufficient incision and dissection. (d) It is an operation in the

* In severe cases several operations—three or more—will be needed. After the first one or two the general condition is said to rapidly improve.

dark. This is an objection of great weight when the gland lies deeply and may be attached to important structures, *e.g.*, the internal jugular. (c) This operation is much more likely to call for repetition than a well-planned aseptic excision on lines widely, carefully, and thoroughly carried out.

CYSTIC HYGROMA; CONGENITAL LYMPHANGIOMA.

Unless these growths are clearly spreading, or causing dyspnoea, they should not be operated upon in early life. The poor vitality and the subsequent restlessness of the patient and small size of the parts, contra-indicate such interference. Where this step is rendered necessary, free incision and drainage of the chief cyst or partial removal of the larger ones, in a multilocular case, and drainage are the wisest steps. But the risk of infection is always great. Where a lymphangioma involves the face, and the presence of the facial nerve is an additional contra-indication, the surgeon's choice, if he be compelled to interfere, lies between multiple incisions, electrolysis, and injections, *e.g.*, of iodine diluted.

THYROGLOSSAL CYSTS.

These, and occasionally solid growths, develop from the embryonic thyroglossal duct, which passes from the foramen cæcum to the isthmus or pyramidal lobe of the thyroid gland. Their liability to form discharging fistulæ in the middle line of the neck, usually situated between the cricoid and the thyroid cartilages, is well known. The only treatment is complete removal of the cyst or fistula with that portion of the thyroglossal duct which remains patent. This is liable to be a matter of some difficulty. A median incision having been made from the hyoid bone down to the upper rings of the trachea, the deep fascia is opened, and the cyst dissected out. If a sinus is present, a fine probe should be passed upwards along its whole length as a guide. It is usually arrested at the body of the hyoid. The puckered skin below and around the opening of the sinus should be removed as well. Mr. Bland Sutton found in one case that the duct bifurcated below, one portion ending at an opening in the middle line of the neck, the other in a blind pouch. In the four cases with which I have had to deal the duct became obliterated at or behind the body of the hyoid, it being impossible to pass a piece of fine silver wire beyond this point. Probably a fibrous tract replaced the rest of the thyroglossal duct up to the foramen cæcum. If the duct be found patent above the hyoid, the incision must be continued towards the chin, the hyoid divided with a fine saw, the two halves and the genio-hyoids separated, and the entire tract which is patent removed. Drainage should be employed in these cases. Excellent illustrations of median cervical fistulæ dating to a patent thyroglossal duct are given by Mr. Bland Sutton (*Tumours, Innocent and Malignant*, pp. 380 and 383). He refers to an instructive paper by Marshall describing the anatomy of the parts in a child æt. 5 (*Journ. of Anat. and Phys.*, vol. xxvi. p. 94). Full details on persistence of the thyroglossal duct will be found in a paper by Mr. H. E. Durham (*Med.-Chir. Soc. Trs.*, vol. lxxvii.).

CHAPTER XV.

OPERATIONS ON THE ŒSOPHAGUS.

ŒSOPHAGOTOMY, ŒSOPHAGOSTOMY, ŒSOPHAGECTOMY. ŒSOPHAGEAL POUCHES.

ŒSOPHAGOTOMY.

Indications.—This is required for such foreign bodies—*e.g.*, tooth-plates, bones, coins—as have resisted careful, justifiable attempts at extraction: bodies which are certain, if left, to lead to grave results—*e.g.*, hæmorrhage, sloughing, deep cervical suppuration, &c.

An early operation is usually indicated; the surgeon must weigh the size and character of the body, the time it has been swallowed, the urgency of the symptoms—*e.g.*, dysphagia, dyspnœa from pressure on the larynx, emphysema,* œdema, &c.—and whether the attempts already made at extraction have been all that are justifiable, and whether the instruments at hand have been appropriate.

It must be remembered that the precise site of the foreign body is not always marked by any external swelling or resistance, nor by accurately referred pain;† furthermore, bougies occasionally give very slight indications of the presence of bodies (even rough ones) in the œsophagus or pharynx. The Röntgen rays have been of much service here.

Thus, Mr. Haslam (*Brit. Med. Journ.*, 1898, vol. i. p. 375) recorded the cases of two children, one aged 5, in which a skiagram showed a halfpenny in the œsophagus at the

* In a case where emphysema already exists with an impacted foreign body it will be wiser to open the œsophagus at once, and not make attempts at extraction. Sir W. Church (*St. Barthol. Hosp. Rep.*, vol. xix. p. 55) gives a case in which swelling of the neck began three hours after the tooth-plate had been swallowed. The next day, after several attempts with a horsehair probang, the plate, which lay midway between the larynx and the sternum, was brought up into the reach of forceps and extracted by Sir W. Savory. Death took place two days later, there being perforation of the end of the pharynx, with suppuration in the neck, mediastina, and left pleura.

† In a case recorded (*Brit. Med. Journ.*, May 7, 1904) by Dr. A. Fullerton, a halfpenny had remained lodged in the œsophagus for seven months without definite symptoms till three weeks before the child's admission, when ulceration probably commenced and the child brought up foul material. The Röntgen rays showed the coin to lie opposite the third and fourth thoracic vertebræ. An unsuccessful attempt to remove it by the mouth made the child very ill and caused her to bring up much foul purulent fluid. A week later the coin was successfully removed by œsophagotomy; it lay $4\frac{1}{2}$ inches below the opening in the œsophagus, and was hooked up to this by a bent probe. The wound in the œsophagus was sutured with formalin catgut. Feeding by the mouth was begun in forty-eight hours.

level of the sternal end of the second rib, the coin having been swallowed four months previously. In the other, aged 3, who had swallowed a halfpenny ten days before admission, the coin was clearly seen just below the upper end of the sternum. In each case the coin was removed by the coin-catcher at the first attempt.

Operation.—The head being somewhat extended and turned to the right* side, and the skin of the neck sterilised, the surgeon makes an incision three inches long from just above the thyroid cartilage to within half an inch of the sterno-clavicular joint,† a little in front of the anterior border of the sterno-mastoid. Skin and fasciæ being divided, the anterior jugular or its branches secured, the cellular tissue in front of the above-mentioned muscle is opened up with a director, and the pulsation of the artery and the bodies of the cervical vertebræ, fifth and sixth, felt for. The omo-hyoid may be drawn down, but it is best to divide this muscle at once, and, if it be needful to seek for the body low down in the neck, the sterno-hyoids and sterno-thyroids also. The sterno-mastoid and large vessels are now drawn outwards, and the trachea‡ inwards, with retractors, the thyroid gland probably showing plainly on the inner side, and the internal jugular, if distended, on the outer. The presence of the inferior thyroid behind the carotid sheath, and that of the recurrent laryngeal running up in the groove between the trachea and œsophagus, must be remembered. Throughout these steps of the operation the bleeding must be most carefully arrested, and the deeper part of the wound, with the important structures around it, kept quite dry.

If the foreign body cannot be felt projecting in the œsophagus—*e.g.*, behind the cricoid—the mouth should be opened with a gag, and a bougie or probang passed, as the flaccid tube walls are naturally in contact. When the œsophagus lies unusually deep, following round the thyroid or cricoid cartilage with a sterilised finger will find it.

When the site of the foreign body has been made out, or when, failing this, it is decided to open the œsophagus low down and to pass probes, &c., a clean incision must be made as far back as possible, so as to avoid the recurrent laryngeal filaments.§

When the tube has been opened, and any bleeding from its walls arrested, the opening is dilated by dressing-forceps, by a probe-pointed bistoury, or by curved forceps passed from the mouth and expanded in the wound. Even after a free opening has been made it may be impossible to dislodge the body, if this, a tooth-plate, has projecting clips, or if it is tightly embraced by the contraction of the œsophageal fibres. In such a case the body should be (if a tooth-plate) divided with bone-forceps and removed in two portions, care being taken to keep hold of each portion with forceps (Lawson, *Clin. Soc. Trans.*, vol. xviii. p. 292).

* The œsophagus lies more to the left side, and operating on the left side allows of freer movement of the right hand, while the left is at liberty to move the larynx, &c.

† If the neck is very stout, or if the parts are swollen, &c., the incision may be from just below the angle of the jaw to close to the sternum.

‡ The larynx should not only be drawn to the right, but tilted over to this side also, as this brings up the œsophagus.

§ Mr. Cook (*Guy's Hosp. Rep.*, 1868, p. 3) drew attention to this point. Both his patients were in the habit of singing; in the first case (*ibid.*, 1858, p. 229) a fine tenor voice was replaced by a bass; in the second, in which the œsophagus was opened farther back, the voice did not suffer.

If, after exposing the œsophagus, the body cannot be felt—which will rarely happen,—metallic probes or soft bougies should be passed through the wound in the œsophagus, and the lower cervical and the upper thoracic portions of this tube carefully explored. The question may now be considered: How far down from the œsophagus can a body be extracted? The most accessible part is, no doubt, its junction with the pharynx, opposite to the cricoid cartilage, and the first two inches below this point.

As far as my knowledge goes, the lowest point from which a foreign body has been removed occurred in the practice of Mr. Bennet May.

Here a child, aged 7, had swallowed a halfpenny three and a half years before. The coin had ulcerated through the œsophagus and opened the right bronchus,* lying partly in this and partly in the œsophagus. It was removed successfully by œsophagotomy.

When the foreign body has been removed, the question of introducing sutures into the œsophagus will arise. These should only be used when the wound in the gullet is clean-cut, not bruised, and when the body has been quickly removed; the sutures should be of fine sterilised gut, and only the upper part of the wound in the œsophagus should be closed, the rest being left open to the bottom to allow of free drainage, owing to the danger of sloughing, pent-up foul secretions, and blood-poisoning (p. 722). A drainage-tube should be inserted to the bottom of the wound, iodoform dusted in, a few sutures placed in the edges of the wound, dry dressings applied—viz., iodoform gauze, salicylic wool, &c.—if the wound has not been much probed about, and there is thus good reason to expect early union. But if ulceration of the soft parts has been found, if they are inflamed, emphysematous, &c., the wound should be left open, drained to the very bottom, and boracic acid fomentations frequently applied.†

After-treatment.—If the patient is in good condition, if the foreign body has been removed early, or if the patient has been able to swallow liquids in the interval between the accident and the operation, he may be fed for the first few days by nutrient enemata and nutrient suppositories, and only a little ice given occasionally by the mouth. But if the strength is not satisfactory at the time of the operation, or if the enemata are not retained, a soft feeding-tube must be made use of. This should be passed by the mouth and retained, if not very uncomfortable to the patient, or passed at intervals. Towards the end of the

* The proximity of important parts to the thoracic portion of the œsophagus is well known. Thus, in *Path. Soc. Trans.*, vol. xix. p. 219, is recorded the case of a man who swallowed a bone which lodged in the œsophagus opposite to the arch of the aorta. Death took place suddenly on the fifth day from perforation of the aorta and hæmorrhage, after a slight exertion. Mr. Eve (*Clin. Soc. Trans.*, vol. xiii. p. 174) gives a case in which a fish-bone, impacted in the œsophagus, wounded the heart fatally. It was thought that the position of the fish-bone was perhaps due to previous use of the probang.

† Mr. D. Armour records (*Brit. Med. Journ.*, April 16, 1904) a case in which, in an attempt to remove a coin in a boy æt. 5, the metal of a coin-catcher separated from the whalebone. The fluorescent screen showed the coin lying as before at the level of the sinus pyramidalis, and an obscure shadow near the lower end of the œsophagus. Gastrostomy was performed, and the portion of the coin-catcher, about five inches long, was removed from the œsophagus by curved crocodile-forceps passed through the cardia along the finger. The coin was removed from above by the same instrument. An excellent recovery followed.

first week, perhaps earlier if the wound is healing well, the patient may be allowed to swallow a little diluted wine or milk.

Chief Difficulties.

- | | |
|-----------------------------------|--|
| 1. A fat, short neck. | 6. Detecting the site of the foreign body. |
| 2. Enlarged veins. | 7. Firm gripping of the body by the œsophagus. |
| 3. Wide depressors of hyoid bone. | 8. The foreign body may be dislodged during the operation. |
| 4. Enlarged thyroid gland. | |
| 5. Unusual depth of œsophagus. | |

Dr. Lediard (*Clin. Soc. Trans.*, vol. xviii. p. 297) records the case of a man in whom emetics and several attempts at removal had failed to dislodge a tooth-plate; emphysema of the neck was present, and some blood on the forceps used. Just before œsophagotomy, a bougie was thought to "scrape" as it was withdrawn. Nothing being felt when the œsophagus was exposed, a bougie was passed, and the œsophagus incised behind the cricoid cartilage; the finger now could detect nothing, and a bougie passed on seemed to feel the plate near the stomach. The plate was passed nineteen days after its impaction; it measured $1\frac{1}{2}$ inch by $\frac{3}{4}$ inch, carried one incisor, and had "numerous sharp points, and a formidable-looking hook at one end." Though there were no laryngeal symptoms, the plate must have been lying behind the lower end of the larynx, as the mucous membrane of the gullet showed here several ecchymoses. The dislodgment of the plate took place either during the passage of the bougie or in the administration of the anæsthetic. The patient made a good recovery.

Causes of Death.—These are chiefly:

1. Septicæmia,* the wound having become emphysematous, sloughy, and the discharge most foul.
2. Exhaustion, when the body has been long impacted, and the patient's health has run down before the operation.

ŒSOPHAGOSTOMY.

This has been proposed as a substitute for gastrostomy. Mr. Reeves, who brought the subject before the Clinical Society (*Trans.*, vol. xv. p. 26), recommended this operation as less dangerous than gastrostomy, and in his belief that cancer of the œsophagus is most frequently met with in the upper part of the tube. The objections, however, are so great as to have prevented any adoption of this operation. They are—(1) The risk of coming close to a mass of cancer, which will not only not admit of dilatation, but which will be rendered more active, sloughy, &c., by the necessary irritation. (2) The fact that important parts are close by, and that the relations of these may very likely be much altered. (3) The probability of finding the œsophagus altered near the disease, and thus, perhaps, readily perforated, admitting fluids into the pleura, &c.

ŒSOPHAGECTOMY.

This is another operation introduced only to be abandoned. Prof. Czerny's case, it is true, was temporarily successful, the patient living rather more than a year after the operation. But cases equally suitable from the site of the disease—only just out of reach of the finger introduced from the mouth—with no glands involved, and no adhesions to

* Mr. Butlin (*Clin. Soc. Trans.*, vol. xvii. p. 129) relates a case in which a tooth-plate was removed within twenty-four hours of its being swallowed, previous attempts at removal, lasting thirty or forty-five minutes, having failed. No difficulty was experienced during the operation, but the patient sank from septicæmia four days afterwards. He was allowed to swallow on the second day, about a third of what was taken coming through the wound. Mr. Butlin considered this beneficial, as conducing to drainage.

adjacent parts, though symptoms had lasted five months, must be quite exceptional. Several of the risks given above would be intensified here, and there would be present as well the need of keeping the fistula patent.* De Quervain has collected all the cases (*Arch. f. Klin. Chir.*, 1899, S. 858).

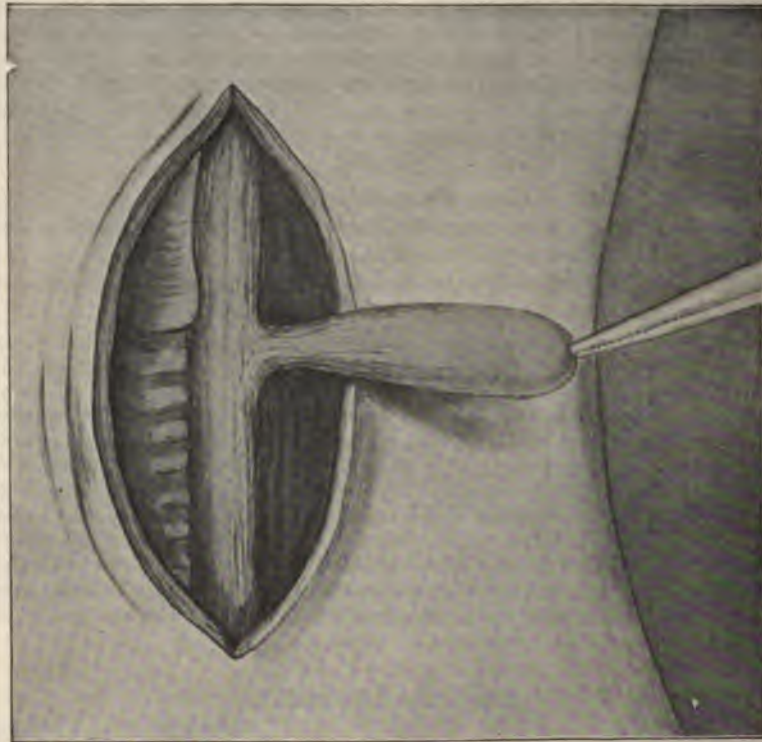
STRING-METHOD OF DIVISION OF NON-MALIGNANT STRICTURES OF THE ŒSOPHAGUS.

This is dealt with under the heading of Gastrostomy (*q.v.*).

REMOVAL OF POUCHES OF THE ŒSOPHAGUS.

This affection has in former years been considered a very rare one. Mr. Butlin, who was one of the earliest operators, and the first in this

FIG. 258.



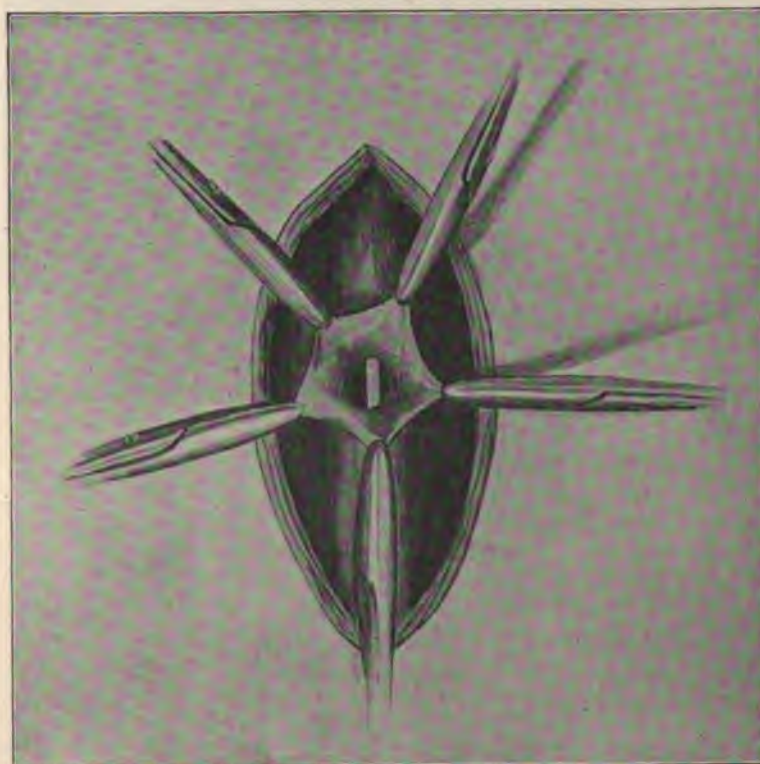
Diverticulum in Dr. M. R. Richardson's first case, freed from its connections and brought out of the wound.

country (*Trans. Med.-Chir. Soc.*, 1893, vol. lxxvi. p. 269), published (*Brit. Med. Journ.*, Jan. 1, 1898) six cases which he has seen, two of

* Mr. Butlin (*Oper. Surg. Malig. Dis.*, 2nd ed.) gives a case of Prof. Billroth's, where death was caused by the passage of the bougie into the tissues round the œsophagus, the opening where the lower end of the œsophagus had been stitched to the skin having contracted. In Mr. Butlin's opinion the results of the fourteen operations collected by De Quervain and others are very discouraging.

which were operated on by him, and with success. In the same periodical (July 11, 1903) he has published eight similar cases. Dr. Maurice R. Richardson in a paper (*Annals of Surgery*, May, 1900) stated that fifty-six cases had then been recorded; of these eighteen had been operated upon, in most with success. Mr. Butlin, in his second paper, states his belief that "the rarity of this condition has been greatly exaggerated, and for this reason: the symptoms of the pouch are not generally known, and are usually mistaken for those of

FIG. 259.



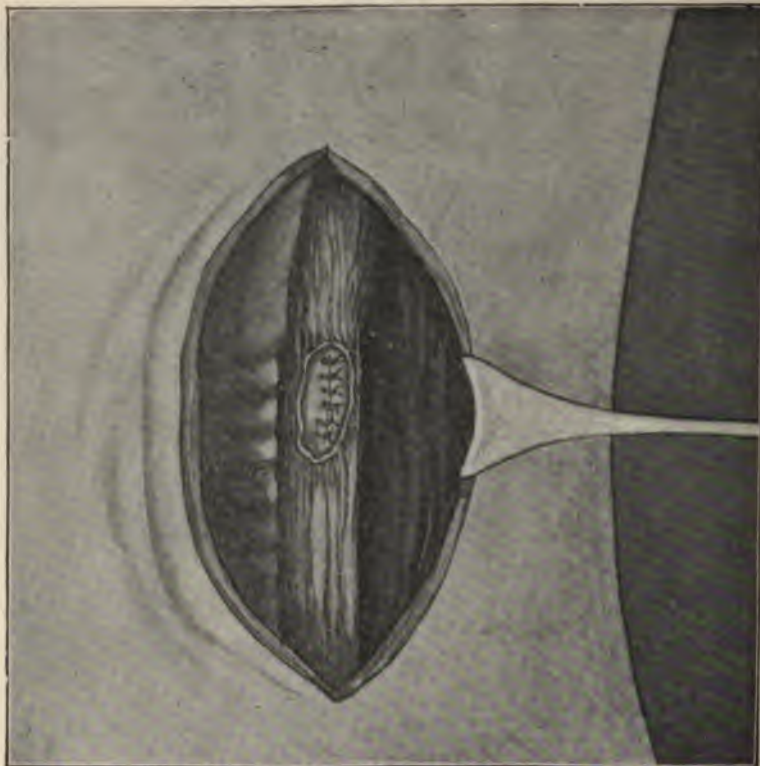
Isthmus of diverticulum in Dr. M. R. Richardson's first case after excision of the main portion. The probang is visible in the œsophageal opening.

a yet rarer condition, viz., pouching of the œsophagus above a stricture, whether innocent or malignant. Both in Whitehead's case (*Lancet*, 1891, vol. i., Jan. 3, p. 11) and Chavasse's (*Path. Soc. Trans.*, 1891, vol. xliii. p. 82), gastrostomy was performed under the impression that the patient was suffering from stricture of the œsophagus, and the real nature of the condition was only discovered after the death of the patient.* The following are the chief symptoms, as given by Mr. Butlin in his paper quoted above.

* In Mr. Whitehead's case, the woman, æt. 57, whose symptoms had existed eight years, died six years after a most successful gastrostomy. Growing weary of this mode

The pouch starts, usually, at the back of the junction of the pharynx and œsophagus (Fig. 262). It occurs much more frequently in males, and the symptoms do not appear to have been noticed before the age of 40. Return of fragments of undigested food is the one constant symptom in every case, not immediately after the food has been taken, but many hours after. The return of food is sometimes associated with severe attacks of coughing. After some time a larger quantity of

FIG. 260.



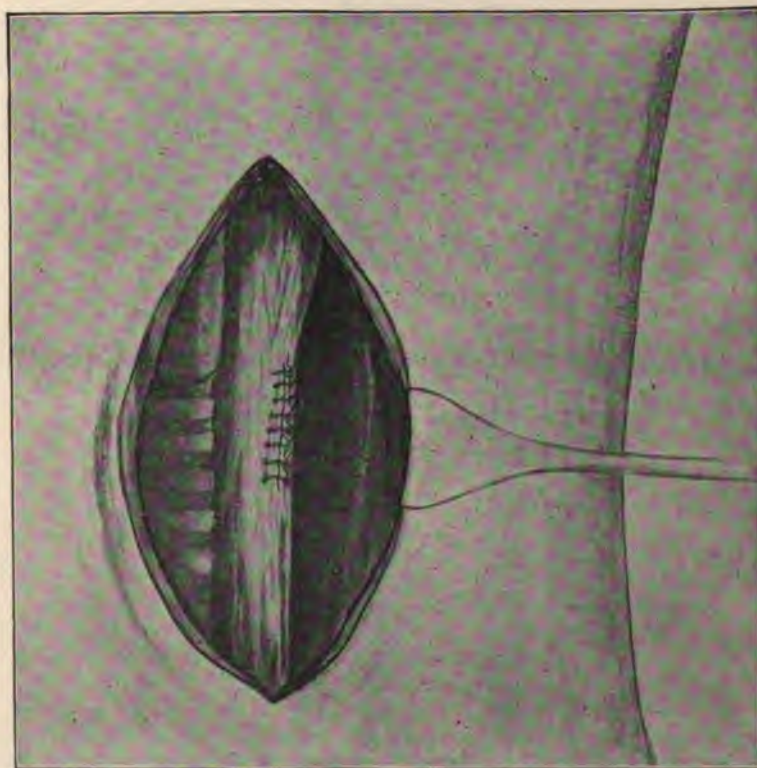
The mucous membrane of the neck of the diverticulum has been inverted and united by interrupted Lembert's sutures of catgut. (Dr. M. R. Richardson's first case.)

food is returned, and the patient becomes aware of some difficulty in swallowing, especially solid food. Pressure on the side of the neck, usually on the left side, causes fragments and liquids to return into the

of feeding, and believing her old trouble to be cured, she resumed feeding by the mouth, and allowed the gastrostomy wound to close. Gradually the old dysphagia returned, and she sank from exhaustion. In Mr. Chavasse's case, the man, æt. 49, applied for relief too late. He was much emaciated from starvation, and sank two days after the gastrostomy. In a case of Landauer's (*Centr. f. inn. Med.*, April 22, 1899), a Röntgen photograph, taken with thin leaden sounds *in situ*, gave more exact information as to the situation of the diverticulum.

mouth, and if not, yet causes the escape of gas which is developed and collects in the pouch, and occasions much annoyance by gurgling up at frequent intervals during movements of the head and neck. If the pouch produces bulging in the posterior triangle, about the level of, or below, the cricoid cartilage, this is a very important symptom, but the absence of bulging does not in the least affect the diagnosis. A bougie is arrested at a distance of about nine inches from the teeth. It may perchance pass into the stomach, gliding over the orifice of the pouch,

FIG. 261.



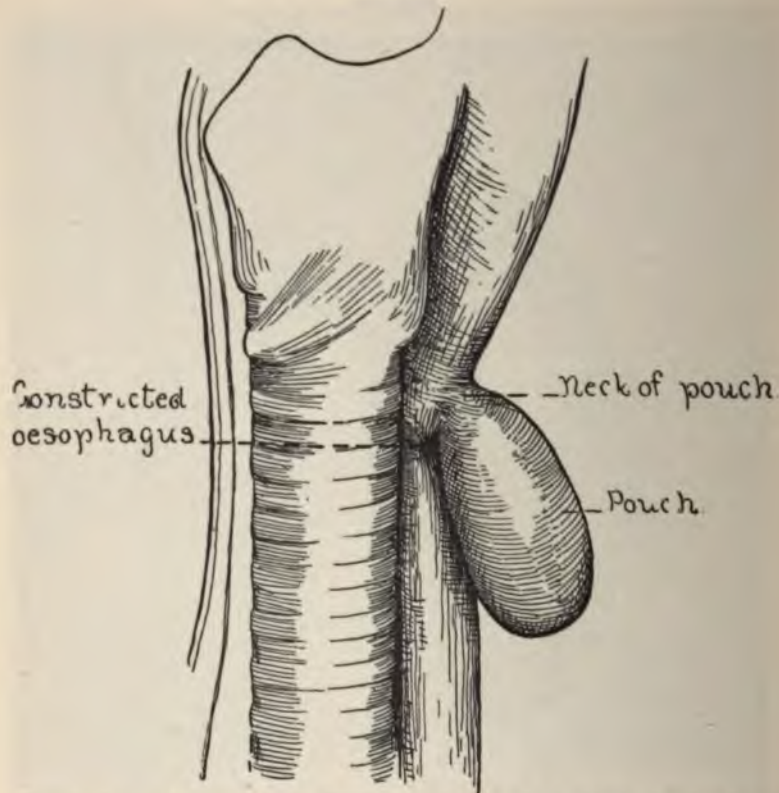
The outer layers of the œsophagus have been closed with silk sutures. (Dr. M. R. Richardson's first case.)

but the rule is that it passes into the pouch; and, as the affection becomes more pronounced, it may be impossible to pass an instrument down the œsophagus. If the bougie be of metal and slightly curved, its end may be made to project so that it can be felt and seen in the side of the neck (almost always the left side), behind the sternomastoid. Wasting and loss of weight are rarely, if ever, observed until the late stages of the disease. In fact, the patient may suffer from unmistakable symptoms of a pouch for years without any sensible loss of weight. Of course, in those cases in which the condition is gradually producing death by starvation, wasting slowly occurs

during the last months or years. The course of the disease is very slow.

Operation.—The patient being under the influence of an anæsthetic,* it would be well, if this has not been already done, to adopt Mr. Butlin's advice and pass a slightly curved metal bougie into the pouch, and, if possible, make its end appear in the posterior triangle, thus obtaining the clearest proof of the presence of a pouch. If possible,

FIG. 262.



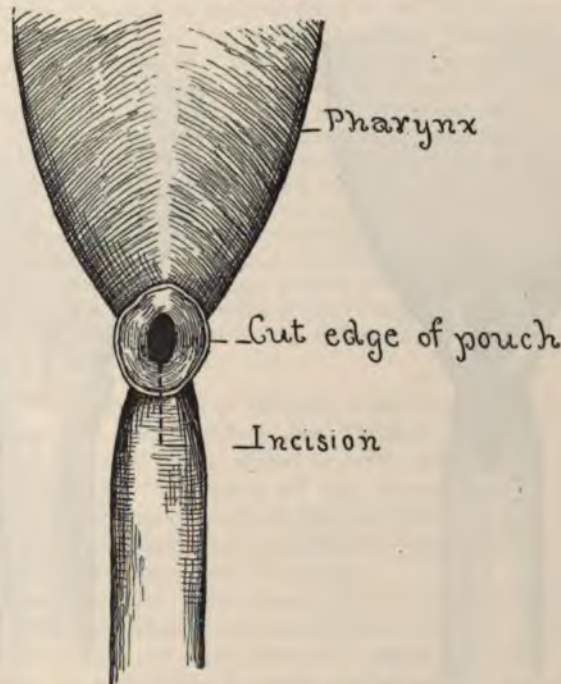
The situation, shape, and size of the diverticulum in Dr. M. R. Richardson's second case.

a bougie should also be passed beyond the orifice of the pouch into the stomach, so as to prove that there is no stricture of the œsophagus. A long incision is then made along the anterior border of the left sterno-mastoid from the hyoid to just above the sternum. The omohyoid is divided, the superior thyroid vessels severed between double ligatures, the carotid sheath drawn outwards, and the larynx rotated on its long axis by drawing forward the left ala of the thyroid cartilage

* Dr. M. R. Richardson, acting upon a suggestion of Dr. Cushing, had a hypodermic injection of atropia given before the ether was administered, in order to keep the mouth and throat dry. "This plan worked admirably."

with blunt hooks. The pouch is then usually easily found lying behind the junction of the pharynx and œsophagus and projecting to the left side. If it be not found at once, careful dissection, aided by the passage of a bougie, will detect its position. It is then grasped by forceps, separated from the surrounding tissues, and drawn upwards out of the wound. The following are some of the methods of dealing with it. Mr. Butlin in his two cases cut away the pouch from above downwards, the margins of the wound being drawn together with eight sutures of fine silk as the sac was cut away. Bleeding does not seem

FIG. 263.



Posterior view of the pharynx and œsophagus in Dr. M. R. Richardson's second case. The pouch has been cut off leaving a circular margin. The dotted line shows the incision through the neck and margin of the pouch, and the constriction of the œsophagus.

to give any trouble at this stage. Another method, that of Mr. Barrow (*Lan.* April 8, 1905), is that of turning back a cuff of the fibrous coat of the œsophagus and suturing this over the gap left in the mucous membrane after the removal of the pouch. Quite a different method is that employed by Girard, of Berne (*Congr. Franc.*, 1896). To avoid opening the œsophagus, he has twice invaginated the pouch so that it projects into this tube. The orifice, which after inversion points externally, is closed by three layers of sutures. Both of these cases were successful, though in one a fistula followed which closed later. The pouch probably becomes atrophied, as it no longer obstructed the passage of food. Dr. A. E. Halstead, of Chicago, relates a case

successfully treated by this method (*Ann. of Surg.*, 1904, vol. i. p. 171).

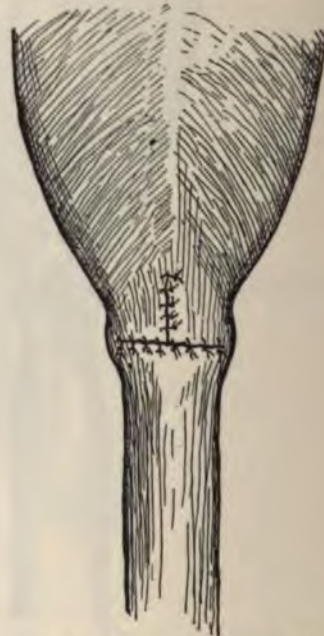
As he states, it is only adapted to diverticula of small size, and cases where the lumen of the œsophagus below the diverticulum is normal. He was able to demonstrate one source of the obstruction caused by the diverticula: "The lower border of the neck of the diverticulum acted as a valve, projecting into the lumen of the œsophagus. Upon introduction of the sound, it came in contact with this valve-like projection, which, upon further pressure, was forced down and completely obstructed the œsophagus, and diverted the sound into the diverticulum." The technique adopted was as follows:—After the sac had been freed from its attachments, "a purse-string suture of catgut was passed round the neck with the sound in the sac. The sound was then withdrawn, and the sac inverted

FIG. 264.



The pouch and œsophagus after the incision. (M. R. Richardson.)

FIG. 265.



The condition of the parts after vertical suturing of the pouch, and transverse suturing of the œsophagus. (M. R. Richardson.)

and invaginated into the œsophagus. The purse-string suture was then tied. Three sutures of catgut were then passed through the neck of the inverted sac. These did not penetrate the lumen of the diverticulum. Over these sutures the longitudinal muscular layer of the œsophagus was united by interrupted catgut sutures. A third layer of catgut sutures transverse to these was introduced. By these the inferior constrictor was brought down, covering the first sutures. A large-sized bougie could be passed without difficulty into the stomach." For five days nutrient enemata alone were given. After this milk was swallowed easily, and without leakage.

Dr. Richardson treated his cases shown in Figs. 258 to 265 as follows:—

In the first case (Figs. 258 to 261) "the tip of the index finger could be thrust into the œsophagus through the circular base of the pouch. This was removed by cutting through the isthmus close to the pharyngeal opening. The mucous membrane was inverted into

the oesophagus and fastened together by a few interrupted fine catgut sutures. The other layers were also inverted and fastened by interrupted Lembert's stitches of silk."

In the second case (Figs. 262 to 265) when "the index finger was passed carefully through the neck of the pouch into the oesophagus a constriction (Fig. 262) lined with friable mucous membrane was found here. Passage of the finger through this constricted portion resulted in a longitudinal tear, which seemed to involve the greater part of the lining. The probang, after being passed by this constriction, could at one time be passed into the stomach; at another it could not. The oesophagus just below the opening of the pouch had the diameter of a lead pencil; externally, from the diverticulum to as far as the dissection extended, it was perfectly normal. Although the mucous membrane seemed normal it was not, for it gave way under the gentlest pressure of the finger. There was constriction at that place, caused either by real pathological changes or disuse. The tear in the oesophagus was converted into a longitudinal slit by extending the incision downward in the posterior wall through the lower border of the isthmus of the sac, and through the constriction (Figs. 263 and 264). Fearing the formation of a permanent organic constriction at the site of the laceration, a portion of the pouch was utilised to enlarge the diameter of the contracted oesophagus. To accomplish this end, a considerable circular margin was left about the opening of the sac (Fig. 263). The lower portion of the margin was brought downward and placed in the gap made by the divided posterior surface of the narrowed oesophagus. The effect of this procedure was to increase the lumen of the oesophagus by the small area of tissue taken from the pouch (Fig. 264). The subsequent effect of this plastic operation showed its advantage, for at no time was there the least obstruction to the passage of the probang into the stomach. After making as good a joint as possible at the beginning of the oesophagus, I closed the mouth of the pouch by inverting the margins remaining after excision, uniting them by interrupted Lembert sutures." As was expected leakage took place, the wound giving escape to about half the quantities swallowed. The wound ultimately closed entirely, the patient regaining normal deglutition and perfect health.

Owing to the very great risk of leakage, some form of drainage must be provided in every case where a diverticulum has been removed. Either a drainage-tube or gauze wicks, or both, or gauze packing must be employed. Only the two ends of the wound are to be closed, though salmon-gut sutures of reserve may be placed in the rest of the wound, to be tightened when the necessity for drainage has ceased, as the wound is sometimes very slow in closing.

Mr. Butlin's advice (*Brit. Med. Journ.*, July 11, 1903) on the closure of the wound and the after-treatment is as follows:—"The less the tissues below the pouch are disturbed, the better. If they are widely opened up, there is a liability to septic inflammation spreading down into the posterior mediastinum. No attempt should be made to close the external wound, however carefully the opening of the neck of the pouch has been stitched up. It should be drained by a soft tube. On the other hand, it is very desirable to close the opening into the oesophagus, for, although the stitches always give way at the end of three or four days, the surrounding tissues are by this time sufficiently recovered to render the risk of spreading septic inflammation much less prominent. If the pouch is of long standing, and if it is of large size, a soft tube should be passed into the stomach and retained as long as is necessary for feeding. If the patient cannot or will not permit this, or vomits the tube, it must be passed over a guide every time food is taken, otherwise almost all the food will pass out through the wound in the neck. If this cannot be done, a tube should be introduced into the stomach through the wound in the neck, and retained there until healing is nearly accomplished."

CHAPTER XVI.

OPERATIONS ON THE SPINAL ACCESSORY, UPPER CERVICAL NERVES, AND SYMPATHETIC.

PARTIAL NEURECTOMY, OR NERVE-STRETCHING.

Indications.—In cases of spasmodic torticollis in which—1. All previous palliative treatment has failed; *e.g.*, large doses of conium, massage, galvanism of the affected side, and faradisation of the opposite muscles. 2. The spasms so severe and constant as to interfere with the patient's taking food or enjoying sleep, and to cause sad weariness and real suffering. 3. The only muscles affected are the sterno-mastoid, or the sterno-mastoid and trapezius.

Anatomy of the Spinal Accessory Nerve.—The spinal or external part of this nerve, having left the skull by the jugular foramen, is directed backwards in front of, or behind, the internal jugular vein, and appears below the digastric and the occipital artery (Fig. 146). It then descends obliquely outwards to the sterno-mastoid muscle, and disappears under this at a distance of two inches from the apex of the mastoid process. Having usually perforated the muscle, the nerve passes across the posterior triangle, to end in the deep surface of the trapezius. While passing through or under the sterno-mastoid the nerve joins with branches from the second cervical. Having emerged from the muscle, it joins with the second and third nerves, and is often in intimate connection with the great auricular and small occipital. When under the trapezius, it is joined by branches of the third and fourth cervical.

Operations for Partial Neurectomy.—The nerve may be found by two different incisions:

A. Along the anterior border of the sterno-mastoid, so as to come upon this nerve before it perforates this muscle.

B. Along the posterior border of the muscle; the surgeon finding the nerve as it emerges here to cross the posterior triangle to gain the trapezius, and following it up to a point above its branches to the sterno-mastoid, so as to paralyse this muscle also.

The first of these operations is, in my opinion, much preferable, and for these reasons:

1. Though the nerve lies more deeply at the anterior than at the posterior border of the muscle, it is here a single nerve, and not likely to be confounded with other nerves—*e.g.*, branches of the second and third cervical, which also emerge at the posterior border to supply the skin. Furthermore, in this latter position the spinal accessory is often found in close connection with the small occipital and great

auricular, as these two nerves appear at the posterior border and curve upwards.

2. By finding the nerve at the anterior border of the muscle, paralysis of the sterno-mastoid is better ensured. When the nerve is found at the posterior border and followed up into the muscle before division, there is always an uncertainty as to whether some branch to the muscle may not have come off above the point at which the surgeon has divided the nerve. And though the nerve is more superficial in the posterior triangle, it is difficult to make certain whether it is the spinal accessory or one of the superficial cervical nerves which emerge close to it from behind the muscle.

A. Operation above the Sterno-mastoid.—The parts having been shaved and sterilised, and the head suitably raised and turned to the opposite side, the surgeon makes a free incision along the anterior border of the sterno-mastoid for 3 inches, commencing at the apex of the mastoid process and ending about 2 inches below the angle of the jaw. Skin, fasciæ, and platysma being divided, the anterior border of the sterno-mastoid is clearly defined, and drawn strongly backwards so as to put the nerve on the stretch. In doing this the posterior and lower part of the parotid may have to be drawn forward if this gland overlap the muscle. The wound being then thoroughly dried, the operator searches for the nerve with a steel director in the fatty connective tissue which lies between the muscle and the carotid sheath. If, in doing this, he keep for his landmark the angle of the jaw, he is almost certain to be on a level with the point where the nerve enters the muscle. If this landmark fail him, he should define the lower border of the digastric, and, tracing upwards the posterior belly of this muscle, feel for the transverse process of the atlas, between the front of which process and the posterior belly of the digastric the nerve emerges to pass backwards to the sterno-mastoid. The small branch from the occipital artery which accompanies the nerve will give no trouble; and if in the deeper parts of the wound only a steel director or a blunt dissector be used, neither the occipital artery nor the internal jugular vein will be injured. A full inch of the nerve should be removed.

B. Operation below or at the Posterior Border of the Sterno-mastoid.—Mr. Campbell de Morgan, who introduced this operation into British surgery with a very successful case,* made an incision, 2 inches long, along the posterior border of the sterno-mastoid, the centre of the incision corresponding to about the centre of this border of the muscle. The fascia being slit up to the same extent, the trapezial branch of the nerve was sought for as it emerges from the sterno-mastoid to cross the posterior triangle. It was found a little above the centre of the wound, and traced through the muscle till the common trunk was discovered above its division into branches for the trapezius and sterno-mastoid. If an inch of the nerve was then cut out.

I have thrice performed the operation of resection of part of the spinal accessory, employing each of the two methods given above.

In 1878, I found the nerve in the posterior triangle, and, tracing it upwards, I found a portion of the common trunk in the substance of the sterno-mastoid. In 1894

* *Brit. and For. Med.-Chir. Rev.*, July, 1866.

I found the nerve at the anterior border of the muscle, taking as my guide the angle of the jaw. Both patients were middle-aged women, the subjects of severe spasmodic torticollis. In each case some of the deep cervical muscles supplied by the upper cervical nerves were affected, and in neither was the result so satisfactory as I wished. In the first no permanent benefit can be said to have resulted. In the second the relief was considerable, and the patient has hitherto declined further operation in the form of division of the posterior branches of the cervical nerves. Atrophy of the sterno-mastoids followed in each case.

In my third case, as both sterno-mastoids were affected, excision of part of each spinal accessory was performed above the sterno-mastoid. While the muscle on the left side remained paralysed, the right contracted afterwards as vigorously as before. There was no doubt whatever that the nerve had been found and part removed, for it was absolutely quiescent for three weeks after the operation. Whether the return of activity was due to reunion taking place, or to the additional nerve supply from the second cervical, must remain doubtful. I find the same result has occurred to Mr. Harsant, surgeon to the Bristol Royal Infirmary (*Bristol Med.-Chir. Journ.*, 1896). This case, of twenty years' duration, was rendered further unfavourable by the number of muscles involved. Thus, when the head was fixed by the sterno-mastoids and trapezii in rigid spasm, the platysma, occipito-frontalis, and orbicularis palpebrarum were also in violent action, the arms were rigid, and the abdominal recti were powerfully contracted. Though on each side three-quarters of an inch of the spinal accessories was removed, it is stated that some weeks later "there was no actual paralysis of either sterno-mastoid or trapezius, which all appeared to contract violently at times."

There is no comparison between the two methods, that in which the nerve is found at the anterior border of the muscle being infinitely easier and more satisfactory.

A very interesting contribution to the literature of this subject is a paper by Mr. Ballance.*

His patient, a woman of 48, was a good instance of the distress and misery due to spasmodic torticollis. Division of the right spinal accessory in the anterior triangle gave most decided relief. At the end of four months, when the history ceases, the patient is reported to have been "much better and stouter. The face is happy and tranquil. There is neither headache nor pain, and sleep and appetite are good. The control of the movements of the head is perfect as long as she is not excited, and so long as the head is not raised so that the eyes are directed much above the horizontal plane in which they lie. . . . The right sterno-mastoid and trapezius are atrophied."

Division of the spinal accessory deserves a further trial, even if the relief given be not permanent.

The chief fear is that other muscles will become involved, as in my cases. Thus, Mr. Ballance writes of his patient: "Since the operation, it has been certain that some of the muscles supplied by the upper spinal nerves are liable to spasm. It would be strange if it were not so, considering the intimate connections between the second, third, and fourth spinal nerves and the spinal accessory in the sterno-mastoid, trapezius, and posterior triangle, together with the fact that some of the fibres of the spinal accessory are connected with the same cells, or with cells in the immediate neighbourhood of those from which arise the motor rootlets of the cervical spinal nerves."

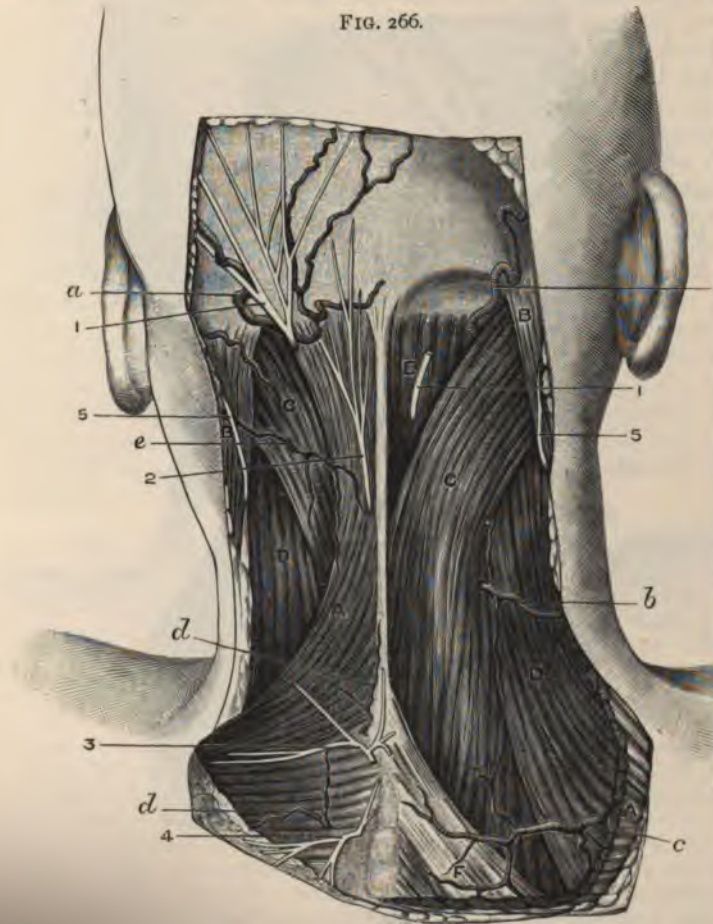
The following conclusions may be drawn with regard to the operation.

* *St. Thomas's Hosp. Rep.*, vol. xiv. p. 95. Other recorded by Prof. Annandale (*Lancet*, 1879, vol. i. p. 55 vol. ii. p. 369).

OPERATIONS ON THE SPINAL ACCESSORY

treatment of spasmodic torticollis:—1. Palliative treatment will have little permanent value, and the earlier surgery is resorted to the better the outlook. 2. The most common combination of spasm is involving the sterno-mastoid on one side and the posterior rhomboid on the other, the head being held in the position of sterno-mastoid spasm with the addition of retraction through the greater power

FIG. 266.

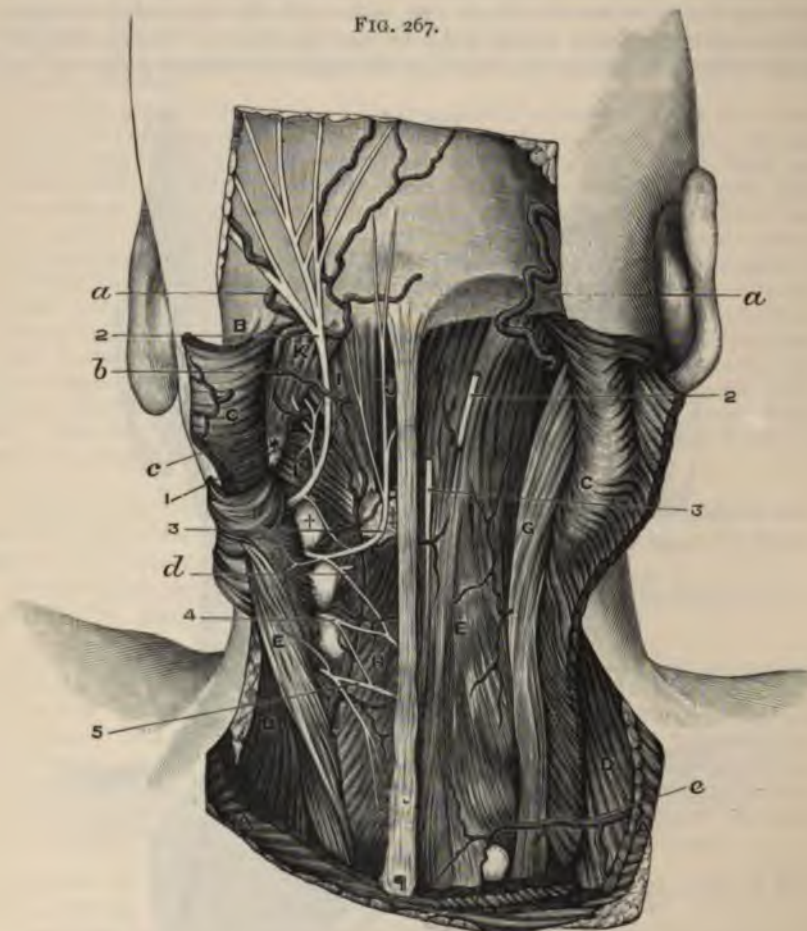


b, Transverse or superficial cervical.
c, Superficial cervical.
d, d, Branches of deep cervical.
e, Cutaneous branch of posterior auricular.

1, 1, Great occipital.
 2, Third cervical nerve.
 3, Fourth cervical nerve.
 4, Fifth cervical nerve.
 5, 5, Small occipital.

posterior rotators (Dr. Maurice H. Richardson and Dr. G. L. Walton, *Amer. Journ. Med. Sci.*, 1895, No. cix. p. 27). 3. Operation on the

FIG. 267.



A, A, Trapezius.
 B, Sterno-mastoid.
 C, C, Splenius.
 D, D, L. anguli scapulae.
 E, E, Complexus.
 F, Rhomboideus minor.
 G, Trachelo-mastoid and transversalis cervicis.
 H, Semispinalis.
 I, Rectus C. posticus major.

J, Rectus C. posticus minor.
 K, Obliquus superior.
 L, Obliquus inferior.
 a, a, Occipital artery.
 b, Princeps cervicis.
 c, Vertebral.
 d, Deep cervical.
 e, Superficial cervical.
 f, Suboccipital nerve.
 1, 1, Great occipital.
 2, 2, Third cervical.

4, Fourth cervical.
 5, Fifth cervical.
 * Transverse process of atlas.
 † Articular process of axis.
 ‡ Spinous process of axis.
 ¶ Spine of seventh cervical.
 (Godlee.)

RESECTION OF UPPER CERVICAL NERVES.

spinal accessory may afford relief, even if other muscles than sterno-mastoid are affected. On the other hand, the affection previously limited to the sterno-mastoid may spread to other muscles in spite of this operation (*ibidem*). 4. No fear of disabling paralysis need deter us from recommending operation, as the head can be held erect even after the most extensive resection (*ibidem*). 5. It is clear from Mr. Harsant's cases as well as my own that, after undoubted resection of portion of the spinal accessory, spasmodic action of the sterno-mastoid may still persist. 6. I have spoken above of the need of resort to surgery early in these cases. The disease will certainly spread from one muscle to another, from one group to another, the abnormal condition of one nerve-centre extending to other closely adjacent centres. Further, it is here as in traumatic epilepsy of any duration (p. 27) that over-excitability of one or more nerve-centres becomes, if left too long, a permanently established condition, and with it over-activity of muscles which are physiologically associated with those nerve-centres.

Resection of some of the Branches of the Upper Cervical Nerves.—In those cases of spasmodic torticollis where, after resection of part of one spinal accessory, mischief still persists in muscles of the opposite side, this step has been practised by Mr. Noble Smith (*B. Med. Journ.*, vol. i. 1891, p. 753), and by Prof. Keen (*Journ. Nerv. & Ment. Dis.*, Dec., 1889), and by Prof. Krause for occipital neuralgia (v. Bergmann's *Syst. Prac. Surg.*, American translation, vol. i. p. 58).

The following are the chief steps in the operation detailed by the latter authority:—

The incision through the thick skin begins at the occiput near the middle line 3 cm. below the external occipital protuberance. Carried outwards and slightly downwards to a point 2 cm. from the tip of the mastoid, it now runs obliquely downwards forwards to the posterior edge of the sterno-mastoid, and ends a little below the level of the hyoid bone. The greater part of the incision runs within the limits of the hairy scalp. The great occipital nerve is found by dissecting the upper lip of the wound upwards; it comes through the upper lateral margin of the thin trapezius to enter the dense connective tissue of this region along a horizontal line 2 cm. below the external occipital protuberance, and at a varying distance from the middle line. The trapezius muscle is divided or displaced inwards according to its development, the splenius and semispinalis also cut through transversely as far as is necessary to give access to the deeper parts. The nerve is followed to where it turns round the inferior oblique, where it is resected. Prof. Krause considers the existence of the third occipital constant. It lies along the inner side of the great occipital, perforating the trapezius about 4 cm. below the external occipital protuberance. It must be followed back through the semispinalis, and below the inferior oblique to its exit between the second and third vertebrae. The small occipital and great auricular will be exposed by the above incision where they appear at the posterior edge of the sterno-mastoid, at about the level of the hyoid bone. In following them backwards towards the spinal column the sterno-mastoid is to be placed forwards and the splenius and other muscles backwards. Care must be taken to preserve the spinal accessory, which frequently communicates with the superficial nerves. The most troublesome bleeding will be met with in the deeper part of the dissection, only to be controlled by compression. Thiersch's method of avulsion is to be employed here owing to the proximity of a very important vessel. The fact that the phrenic may arise from the third cervical nerve is also found helpful in dealing with the deeper part of the dissection. The wound should be closed by buried sutures. The wound should be closed by buried sutures.

Figs. 266 and 267, from Mr. Godlee's atlas, illustrate the anatomy of the region.

RESECTION OF THE CERVICAL SYMPATHETIC FOR EXOPHTHALMIC GOÏTRE, Etc.

Owing to the uncertainty of the results and the dangers accompanying partial thyroidectomy in exophthalmic goitre (p. 697), some surgeons in recent years, relying on the suggestion, originally, I believe, put forward by Trousseau, that the three cardinal phenomena of the disease are due to some disturbance of the cervical sympathetic, have practised removal of these ganglia. This method of treatment does not appear to me to be based on sound foundations, or to be followed by good results with sufficient constancy to justify our resorting to it. Thus, even if morbid changes in the ganglia were constantly present in this disease (a postulate which cannot be conceded), any attempt to explain the three cardinal symptoms of exophthalmic goitre is unsatisfactory. Thus, while the exophthalmos and the goitre may be explained by paralysis, the third chief feature, the excited heart's action, means irritation, not paralysis, of the above ganglia. It must be remembered that the removal of the sympathetic chain, always a difficult operation, is rendered more so by the presence of the goitre, and that those points which have been fully alluded to above, viz., the poor vitality of the patient, the risks of the anæsthetic, the dangers of thyroidism, have to be faced here also.

With regard to the results of this mode of treatment of exophthalmic goitre, I cannot find that they are more constantly beneficial than those following partial thyroidectomy, and this is especially the case with reference to those nervous symptoms which are so frequent and distressing a feature in this disease.

The following are amongst the papers by surgeons who have made use of this operation :—

Jaboulay, who first gave prominence to it (*Lyon Méd.*, Feb. 7, 1897; *Presse Méd.*, Feb. 12, 1898), gives in the second paper eleven cases, and speaks of the operation as especially preferable to partial thyroidectomy in those cases in which the goitre is not a prominent feature. Péan (*Presse Méd.*, Aug. 4, 1897) obtained relief to the pressure symptoms, but not to those which may be termed nervous. Poncet (*Presse Méd.*, July 28, 1897) claimed benefit in nine cases. In the hands of Chauffard and Quénu (*Presse Méd.*, July 3, 1897) the result was entirely negative. Gouget (*Lyon Méd.*, Nov. 30, 1896) speaks favourably of Jaboulay's method, and claims that the three cardinal features of exophthalmic goitre are powerfully influenced by it. Réclus (*Presse Méd.*, June 23, 1897) reports a case completely cured by this treatment. Schwartz (*Bull. et Mém. de la Soc. de Chir. de Paris*, Nov. 22, 1898) reports two cases treated by bilateral resection of the cervical sympathetic. In both cases the operation is stated to have given much relief, bringing about less marked exophthalmos, reduced frequency of the pulse, and gradual improvement in the general symptoms.

B. Farquhar Curtis, of New York, discusses the various operations for exophthalmic goitre (*Trans. Amer. Surg. Assoc.*, 1903, p. 303), with especial reference to the merits of thyroidectomy and sympathectomy. Having met with three deaths in eleven cases of thyroidectomy from acute thyroidism alone, without wound complications, and attracted by the results claimed by Jonnesco for complete bilateral removal of the cervical sympathetic, Dr. Curtis operated in seven cases, but, as there were two deaths from acute thyroidism, and one probably due to the anæsthetic, his results have not been better. While it is allowed that it was early to judge of final results, it is claimed that "three

cases were cured, one improved, none unimproved." Three cases died. **Operation.**—The following points are emphasised. The incision should be along the anterior border of the sterno-mastoid, the large vessels exposed with the goitre displaced to the inner side, the sympathetic trunk exposed in the middle of the wound, and traced to the upper ganglion. The latter is isolated by forcible retraction of the upper angle of the wound in a good light, the nerve clamped just above the ganglion, and this body twisted out. The nerve is then followed down, and the second and third ganglia isolated and removed. The inferior thyroid artery, which may have nerve filaments in front of and behind it, may need ligation.

The second ganglion is often small or fused with the third.

The third is often fused with the first dorsal, and will have to be separated with scissors or knife after blunt isolation. "I look upon this part of the operation as the most difficult, because of the depth of the ganglion and the proximity of important structures. The recognition of the nerve also presents serious difficulties in some cases. It is very variable in size and appearance. In any case it should be a cardinal rule not to inflict any damage upon a structure supposed to be the nerve until it has been proved to be the sympathetic by tracing it to either the upper or the lower ganglion."

The bilateral removal of the sympathetic should be done in two stages, with an interval long enough to permit the patient to recover from the effects of the first operation. A trial should be given to local analgesia, but owing to the increased difficulties due to the presence of the goitre, the success of this is doubtful. Where only one side is operated on, the operation is one of about an hour.

Dr. Curtis thus summarises his conclusions:—"Results.—Exophthalmic goitre can be cured both by thyroidectomy and by sympathectomy. A perfect result can be expected in about 60 per cent. of the cases of thyroidectomy. An immediately good result appears to be the rule in sympathectomy. Sufficient time has not elapsed to judge of the permanence of the cure, but the immediate results of sympathectomy are far superior to those of thyroidectomy. **Mortality.**—The relative mortality of the two would also seem to favour sympathectomy (Kocher, four deaths in fifty-nine cases of thyroidectomy or ligation only; Jonnesco, none in fourteen cases of sympathectomy), although in my own cases the result is the opposite. There is serious danger of fatal acute thyroidism after both operations."*

v. Eiselsberg's conclusions (v. Bergmann's *Surgery*) are much less hopeful: "The results of this operation seem to be far less favourable than the results of operation upon the thyroid gland, although too few cases have been reported to allow of an absolute statement. The only symptom that seems to be favourably influenced constantly is the exophthalmos. Tremor and tachycardia persist in almost all the cases, and the general condition has not been improved. Diminution in the size of the goitre, which has been reported, is in all probability due to ligation of the thyroid arteries. The dangers of this operation are at least as great as those of strumectomy, if not greater. The results of operation upon the sympathetic nerve do not compare favourably with the success of partial strumectomy."

The other conditions for which removal of the cervical sympathetic has been chiefly practised are epilepsy and glaucoma.

With regard to epilepsy, Jonnesco claims a certain proportion of cures, but the interval that had elapsed is too short to allow of a judgment of any value as to the final results. According to Braun's more recent experience, the operation is negative. In the case of glaucoma, the results of Jonnesco, who first removed the cervical sympathetic in 1897, are given by Mr. Burghard (*loc. infra cit.*). Later results will be found much less

* Dr. Curtis publishes the later results of his cases (*Ann. of Surg.*, March, 1906, p. 336). His candour shows us that the above claims were not maintained. Of the above given four cases treated by sympathectomy, one relapsed within nine months, and a little over a year after the operation died of the original disease and acute endocarditis. One case was improving, when she acquired nephritis, a cardiac lesion and œdema of the limb, from which early death was expected. One case was completely cured five years after the sympathectomy. "The remaining patient is able to do her work and enjoy life without medication, although goitre, exophthalmos and slight tachycardia persist, a practical cure." Dr. Curtis has concluded to again turn his attention to thyroidectomy.

favourable. Wilder, of Chicago, gives (*Journ. Amer. Med. Assoc.*, Feb. 2, 1904) a detailed report of seven cases of removal of the cervical sympathetic still under observation in his own practice, and adds briefly the results of operations by others on fifty-four cases. The results are not very encouraging. In certain of the cases in which improvement at first followed the operation, relapses are reported. The following sequelæ of the operation have been noticed: myosis, ptosis, congestion of conjunctiva, hoarseness or aphonia, dysphagia. Wilder is inclined to advise, "In acute glaucoma, and in the subacute with intermissions, practise first iridectomy, and if it fails, do sympathectomy. In simple glaucoma use myotics five times a day; if they suffice, continue them. If, in spite of their systematic employment, the vision fails, do sympathectomy."

An interesting paper by Mr. Burghard on excision of the superior cervical ganglion will be found in the *Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1175. The operation was performed on three occasions for very different conditions: in the first case, for the relief of subacute glaucoma; in the second, for the removal of an enlarged epitheliomatous gland adherent to the upper ganglion; and in the third, for a variety of false neuroma which had attacked the ganglion. Here the middle ganglion was removed as well. The operation was successful in the second and third cases; in the first no benefit followed.

OPERATIONS ON THE BRACHIAL PLEXUS.

These have been chiefly performed in cases of laceration of the plexus, for compression by scars, exostoses, &c., and lastly in that form of birth-paralysis in which the muscles chiefly affected are the deltoid, biceps, and brachialis anticus. I am not aware of any case in which surgery has been successful in curing a case of the first description where several of the lower cervical nerves have given way at the level of their spinal attachments. Mr. Thorburn (*Brit. Med. Journ.*, May 5, 1900) relates in detail a case of operation, performed about seven months after the injury, resulting in recovery of sensation and certain movements of the shoulder to an imperfect degree. As is so frequently the case in hospital practice, the patient took no pains to contribute her share of the after-treatment. Compression cases are, of course, more favourable. Dr. R. Kennedy, of Glasgow (*ibidem*, vol. i. 1903, p. 298), records a case of practically complete recovery after operation on a scar involving the plexus. He also deals here with the subject of birth-paralysis alluded to above. Three cases of operation for this condition are given. In one, in which sufficient time had elapsed, the result was most satisfactory, flexion of the forearm and abduction of the shoulder being regained.

Mr. Tubby (*Brit. Med. Journ.*, 1903, vol. ii. p. 975) has proved that in some of these cases of paralysis of the upper root of the brachial plexus dating to birth muscle-grafting may be employed with benefit. To remedy the inability to flex the elbow, the triceps is exposed by a long incision at the back of the arm much as for the musculospiral nerve (p. 164), and brought forwards below. The nerve having been found and drawn aside, the outer head of the triceps is detached from the tendon above the olecranon and stripped upwards for three or four inches. The biceps is next exposed and cleaned in its lower part. An aperture having been made in this muscle two inches above the elbow, the strip of triceps is drawn through from behind forwards and firmly pleated down (Fig. 37, p. 56). In two cases voluntary flexion of the elbow joint was obtained in four to six weeks.

To obtain abduction at the shoulder joint, part of the pectoralis major and trapezius were detached from the clavicle and united to each other and then attached to the deltoid or humerus. The result may be said to be promising.

CHAPTER XVII.

LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.*

LIGATURE OF THE TEMPORAL ARTERY.

Indications.—These are very few, viz. :

1. Wounds—*e.g.*, stabs and gunshot injuries.
2. Aneurysm, usually traumatic.

Mr. Skey (*Oper. Surg.*, p. 289) met with a case of aneurysm of doubtful origin in this artery in a young lady. Ligature of the vessel below having failed, he cured his patient by means of a fine spring-compress with a ball-and-socket joint, which, passing over the head entirely concealed by the hair, made pressure on the tumour.

Aneurysms have been known to occur here after the operation of arteriotomy. They should be treated, as the one just recorded would be, nowadays, by the old method.

GUIDE.—A line drawn upwards over the root of the zygoma, midway between the condyle of the jaw and the tragus.

RELATIONS.—Given off behind the jaw, this vessel passes up, midway between the above two points, over the zygoma, and at a point $1\frac{1}{2}$ or 2 inches higher up it divides into its anterior and posterior branches. Lying at first in the parotid gland, it is covered a little higher up by a dense fascia passing from the parotid to the ear, by the *attrahens aurem*, often a lymphatic gland, and one or two veins which lie superficial but close to it. Some branches of the facial nerve cross it, while the auriculo-temporal nerve accompanies it closely. Higher up, the artery and its branches are particularly subcutaneous.

Operation.—The parts having been shaved and sterilised, the head fitly supported and turned to the opposite side, an incision about one inch long is made in the line of the artery so as to tie it just above the zygoma. The dense subcutaneous tissue and the strong parotid fascia being cleanly divided, the artery must be accurately defined, and the vein being drawn to one side, usually backwards, the ligature should be passed from behind forwards, care being taken to include only the artery.

Arteriotomy.—A few words may be said here about this seldom-used operation. The surgeon, having defined the anterior division of the temporal, steadies the vessel by placing his finger just beyond the point which he intends to open, and then with a small sharp scalpel lays open the vessel till it is about half cut through. The blood required having been removed, he divides the vessel completely, so as to allow the ends to retract, applies

* Ligature of the thyroid arteries has already been considered (p. 707).

a pad of sterilised gauze, and retains this in position with the twisted or knotted bandage for the head. The pad should not be removed for four or five days.

The reasons for preferring the anterior division to the trunk of the vessel are the following :

- (1) The latter lies much more deeply, under fasciæ, and in the parotid below ; thus so much pressure may be required to stop the bleeding as to cause sloughing, secondary hæmorrhage, and dangerous erysipelatous inflammation.
- (2) Injury to one of the adjacent nerves may cause severe pain and tedious healing.
- (3) From opening a vein at the same time an arterio-venous aneurysm may result.

LIGATURE OF THE FACIAL ARTERY.

Indications.—These are much the same as, but still fewer than, those for ligature of the temporal artery.*

The vessel's course is divided into a cervical and a facial part.

Cervical Part.—The vessel is reached by an incision similar to that for the external carotid (p. 774) or the lingual (p. 748). In either of these cases it would be found just below the posterior belly of the digastric and the stylo-hyoid, these muscles being drawn upwards to enable the surgeon to ligature the vessel just before it enters the submaxillary gland.

RELATIONS IN THE NECK.—The facial artery is given off just above or in connection with the lingual, about an inch above the bifurcation of the common carotid. It passes upwards and inwards to the lower jaw, being covered by skin, fasciæ, and platysma, the digastric and stylo-hyoid, and embedded in the submaxillary gland, to which structure the vein lies superficial. The tortuous outline of the vessel is well known. The vein, running a straighter course, lies posterior to the artery.

Facial Part.—The artery is readily secured by a small horizontal incision just below the jaw in front of the masseter muscle, the anterior border of which should be first defined, this being easily done on the living subject by telling the patient to throw it into action. The incision should be made carefully, so as to avoid any branches of the facial nerve which may lie in the way. The artery will now be felt when rolled upon the bone by a finger. The ligature should be passed from behind forwards, so as to avoid the adjacent vein.

LIGATURE OF THE OCCIPITAL ARTERY.

Indications.

1. Stabs.
2. Gunshot wounds.

In the *Medical and Surgical History of the War of the Rebellion*, part i. p. 422, two cases are given of secondary hæmorrhage after wounds of the neck, in the one case from the occipital, in the other from a branch of it: in the former case 16 ounces of blood were lost. The vessel was tied in the wound in each case, two ligatures being, of course, applied.

3. In the treatment of arterial varix, cirroid aneurysm, or aneurysm by anastomosis on the head (p. 769).

* The reader is advised to take every opportunity afforded upon the dead body to tie these and other arteries, though apparently so small and unimportant, as only by such practice can dexterity be really acquired.

4. For hæmorrhage from an abscess in the neck. Sir W. Mitchell Banks* published a most instructive case :

A weakly man, aged 32, had had a suppurating gland incised three weeks before admission. Poultices were applied, and a week after, during a violent attack of coughing, blood burst from the wound "like a tap being turned on." Three times afterwards hæmorrhage ensued, pressure being applied in vain. On admission he was in the last stage of exhaustion. The right side of the neck from ear to clavicle was occupied by a great fluctuating swelling. In front of the sterno-mastoid, about half-way down was the original incision, from which a little sanious discharge was issuing. Behind the muscle a piece of skin about an inch square was actually sloughing from the subjacent pressure. Under ether, and in a good light, the original incision was enlarged upwards and downwards, and a quantity of putrid broken-down clot turned out. Then a similar incision was made behind the sterno-mastoid through the sloughing skin. Everything being mopped and cleaned up, blood was found to be trickling down from somewhere very high up. To get at it, the sterno-mastoid and skin over it were cut clean across, thus uniting the two vertical incisions by a transverse one. The muscle was dissected upwards, exposing the sheath of the carotid vessels, but still the blood always kept running from some deep-seated point high up. At last this was reached, just in front of the transverse process of the atlas. From it arterial blood issued, and an aneurysm-needle was thrust through the tissues on each side of it and ligatures applied, which at once checked all further bleeding. The vessel was the occipital artery not far from its origin. Into it the abscess had made its way. The great wound was rapidly swabbed out with turpentine and then stuffed with lint dipped in the same. The patient was very near to death's door, but ultimately recovered.†

RELATIONS.—A posterior branch of the external carotid, the occipital comes off opposite to or a little above the facial, just below the digastric. It at first ascends, having the ninth nerve hooking round it, under the

* *Clinical Notes upon Two Years' Surgical Work at the Liverpool Royal Infirmary*, p. 161.

† Such was the patient's condition that the surgeon was quite prepared for his dying under the operation. The following characteristically vigorous words conclude the account: "But I was determined, as long as he had any blood to run out of him, the place whence it came should be found and tied." In connection with this case may be quoted, in his own words, some remarks of the writer on the value of turpentine as a cleansing styptic. This remedy has again lately been recommended, and it is only fair that Sir W. Mitchell Banks should receive the credit of having recognised its value many years ago. "In former days it was the regular thing for oozing, until superseded by the introduction of perchloride of iron. This has always seemed to me most unfortunate, as iron is the very worst of all styptics. Owing to its great potency and the rapidity with which it acts, it soon became popular, and is at the present moment the favourite stand-by of the chemist, who diligently swabs with it every cut that is brought into his shop, preparatory to sending the patient off to a hospital. As a result, the wound is covered with a cake of coagulated blood, and its surfaces are sometimes positively killed by the strength of the application. Beneath this firmly adherent crust all sorts of purulent, filthy secretions accumulate, till at the end of forty-eight hours it stinks abominably, and requires to be well poulticed to get it clean. Should bleeding recur, the difficulty of finding the spot is enormously increased by the mass of pus and almost cineritious hard clots which cover it. I have seen so many cut hands almost ruined by it that I have totally abandoned it. On the other hand, turpentine is nearly as powerful a styptic, and is a most marvellous cleanser and sweetener. The plug, soaked in turpentine, comes out quite easily at the end of four-and-twenty hours, leaving a wholesome surface behind it. For all wounds about the perineum, such as lithotomy wounds, fistula cuts, or incisions for extravasation of urine, there is nothing like it, and I trust it will soon be reinstated in surgical favour. Our forefathers had some excellent remedies, and this is one of them."

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digastric, stylo-hyoid, and parotid, and crossing the internal carotid, internal jugular, vagus, and spinal accessory. Having reached the interval between the transverse process of the atlas and the mastoid process, it now, in the second part of its course, turns horizontally backwards, grooving the temporal bone, covered by the sterno-mastoid, splenius, digastric, and trachelo-mastoid, and lying on the complexus and superior oblique. In the third part of its course it runs vertically upwards, piercing the trapezius, and ascending tortuously in the scalp.

Operations.

1. If the artery require securing low down, this may be effected much as in tying the external carotid, an incision being made along the anterior border of the sterno-mastoid, the deep fascia opened, and the digastric and ninth nerve exposed.

2. To tie the artery behind the mastoid process, *e.g.*, when it has been wounded by a stab in the neck, the following steps should be taken: The parts being sterilised, and the head at first being placed in much the same position as for ligature of the carotids, an incision is made from the tip of the mastoid process rather obliquely upwards, so as to lie over a point midway between the mastoid and the external occipital protuberance. The tough skin and fasciæ being incised, the sterno-mastoid, in part at least, with its strong aponeurosis, and next the splenius capitis, must be divided, together with any fibres of the trachelo-mastoid that are in the way. The wound being somewhat relaxed by turning the head over to this side, retractors deeply inserted, and an electric lamp used if needful, the artery will be found deep down between the mastoid process and the transverse process of the atlas.

In separating it from its vein, one or more veins varying in size may be met with, forming communications between the occipital and mastoid veins, and thus with the lateral sinus. The wound should therefore be kept rigidly aseptic.

LIGATURE OF THE LINGUAL ARTERY (Fig. 268).

Indications.

1. Before removal of the tongue. This subject has been considered at p. 591. 2. After removal of the tongue, to arrest hæmorrhage. 3. In cases of tongue cancer not admitting of operation, in the hope of checking the rate of growth, diminishing the fœtor, profuse salivation, &c. This step is uncertain as to the amount of good which it effects, and any good that it may do will not be long-lived.* 4. In cases of

* Mr. Haward (*Clin. Soc. Trans.*, vol. x. p. 129) related a case in which he tied the left lingual artery for recurrent epithelioma. The recurrent growth was the size of half a walnut when the lingual artery was tied. It at once ceased to grow, became pale, and in a few days was sloughing. Gradually separation of the growth went on, until the affected side of the root of the tongue became even smaller than the sound side, and eventually the part healed. A fortnight after this took place, or three months after the ligature of the artery, the patient died of pyæmia, set up by erysipelas coming on after the operation. Mr. Haward pointed out that the greater part of the tongue had been removed before the ligature of the lingual, so that therefore the anastomoses between the arteries of the two sides would be greatly diminished. I think, also, that the fact that Mr. Haward was obliged to tie the artery close to the external carotid

macroglossia this operation may be tried before removing a wedge-shaped piece of the tongue; it would require to be performed on both sides, and would be attended with considerable difficulty in a child. It might do too much.

RELATIONS.—The lingual artery arises about a quarter of an inch above the superior thyroid, often in common with the facial, and at a point opposite to the great cornu of the hyoid bone. It first ascends to a point rather above the level of the hyoid bone, then descends somewhat and runs just above the great cornu, and finally, ascending to the under surface of the tongue, it runs forward with a tortuous course to the tip as the ranine.

For practical purposes the relations of the artery may be subdivided into **three parts**—the **first**, before it gets under the hyo-glossus; the

FIG. 268.



The submaxillary gland is seen in the upper part of the wound. Below this is the hypo-glossal on the cut hyo-glossus. A ligature is passed between the lingual artery and vein. A hook depresses the great cornu of the hyoid bone. The lower part of the hyo-glossus is reflected. Lowest of all is the digastric.*

second, while it lies beneath this muscle; and the **third**, beyond this muscle.

In the **first** it runs very deeply, though only covered by the skin, platysma, and fasciæ, facial, lingual, and some pharyngeal veins; it lies upon the middle constrictor and the external laryngeal nerve.

In the **second part** of its course the artery again lies upon the middle constrictor, and is now covered by the hyo-glossus, hypo-glossal, part of the mylo-hyoid, and the lower border of the submaxillary gland.

may have contributed to the sloughing, by cutting off the entire blood supply, especially that through the dorsalis linguæ.

On the other hand, Billroth (*Clin. Surg.*, p. 113) states that, in one case of the tongue, "the lingual artery was ligatured on both sides, in the hope that the tongue in the cavity of the mouth might diminish. However, to no good results, nor did any rapid breaking down of the already ulcerated occur."

* The lingual artery is here drawn too large, and too much of cleaned; the depth of the wound is not sufficiently represented.

From this part come off the four branches of the artery—the hyoid at the outer or posterior edge of the hyo-glossus, the dorsalis linguæ under this muscle, and the sublingual and ranine at its anterior border, thus allowing room for placing a ligature.

The third part lies in the mouth, and runs along the under surface of the tongue up to the point of the frenum. It is only covered by mucous membrane. A vein runs with it, and a large branch of the gustatory nerve.

Operations.

i. Ligature under the Hyo-glossus.

ii. Ligature of the First Part of the Artery.

i. The vessel is usually tied while under the hyo-glossus muscle, owing to the useful guide which the great cornu of the hyoid bone forms, and this is the operation which will be described here (Fig. 268). Were I tying the artery previous to removal of the tongue (p. 591), I should do this close to its origin by an incision similar to that for the external carotid (p. 774), so as to make sure of getting behind the dorsalis linguæ. The parts being sterilised, the head suitably supported and turned to the opposite side, and the lower jaw firmly closed, the surgeon, standing or seated on the same side, steadies the tissues between his left finger and thumb, and makes a curved incision with its centre just above the great cornu of the hyoid bone (a point previously carefully noted), and reaching, *e.g.*, on the left side, from just below and to the left of the symphysis downwards, backwards, and then upwards towards the angle of the jaw, ending just anteriorly to the line of the facial artery.

The incision divides skin, superficial fascia, and platysma; the deep fascia is then opened, and any branches of the anterior jugular, facial, or communicating branch with the temporo-maxillary vein are secured carefully, so that the wound may be kept as dry as possible. The lower border of the submaxillary gland, which probably projects into the wound, is turned upwards* and the hypo-glossal nerve sought for, which lies deeper, and is a good guide to the hyo-glossus. Lower down in the neck is the glistening tendon of the digastric attached to the hyoid bone. The hyo-glossus being defined, the hyoid bone is carefully steadied by a finger-nail or tenaculum, a director passed under the hyo-glossus, and this muscle divided cautiously. In doing this the lingual vein must be carefully looked for either on the muscle or beneath it, with the artery. The artery having been found under the muscle just above the hyoid bone, it should be traced backwards, so as to apply, if possible, the ligature behind the origin of the dorsalis linguæ. Adequate drainage must be provided, and every care taken to prevent decomposition in a wound so deep, and opening up several planes of deep cervical fascia.

Any enlarged glands will, of course, be removed.

Guides and Aids to finding the Artery.

1. A sufficiently free incision. 2. Carefully defining the hypo-glossal nerve, and remembering the relative position of the submaxillary gland,

* The submaxillary gland should be gently handled, and not cut into. Otherwise in the one case troublesome swelling, in the other temporary weeping of saliva, or even a fistula, will be the result.

the digastric tendon, and the great cornu of the hyoid bone. 3. Keeping the wound bloodless.

Difficulties.

i. Matting of the parts from old cellulitis. 2. Presence of large veins. 3. Depth of the wound, and oozing low down from the severed hyo-glossus. 4. In one case Dr. Shepherd (*Annals of Surgery*, vol. ii., No. 11, p. 359) found the digastric so extensively tied down to the hyoid bone by the deep cervical fascia as to require separation. 5. The position and condition of the lingual vein alike are at times perplexing. Usually two small venæ comites accompany the artery, while the main vein lies on the hyo-glossus; occasionally it lies under it, with its artery. Billroth (*Clinical Surgery*, p. 113), who has tied the lingual artery twenty-seven times, tied the vein for the artery in one case, as was verified at the necropsy. "Every surgeon knows the difficulty of tying the lingual artery in old people; the vessel lies so deep that it is very difficult to distinguish it from thick-coated distended veins, especially when, owing to heart disease—as in this case—the veins pulsate. Never previously had I met with a lingual vein of such thickness." 6. Abnormal position of the lingual artery itself. This is rare, but the artery may lie higher than usual; it may pierce the hyo-glossus; occasionally one lingual is minute or absent. 7. The submaxillary gland may be unusually large and occupy much of the space between the jaw and the hyoid bone.

ii. If the vessel cannot be found on the hyo-glossus, or if the condition of the soft parts is such, owing to cellulitis, matting, or enlargement of glands, as to prevent any attempt being made here, the surgeon must cut down upon the **first part** either by an incision similar to the above but less curved, and running from the centre of the hyoid bone just above the great cornu to the anterior border of the sterno-mastoid, or by one similar to that used for ligature of the external carotid, with its centre opposite to the hyoid bone.

The difficulties are not great. It needs only to remember that—
1. The artery itself is not constant in position here, varieties occurring frequently in the height at which it comes off from the external carotid, whether alone, or in common with the facial. 2. Large veins—*e.g.*, the lingual and facial—will certainly be present.

LIGATURE OF THE COMMON CAROTID (Fig. 269).

Indications.

1. In wounds of the trunk itself. Owing to the rapidly fatal issue of such injuries, the surgeon is not often called upon to meet them. Cases indicating ligature for wounds of the trunk may be grouped as follows: (a) for immediate hæmorrhage; (b) for secondary hæmorrhage; (c) for gunshot injuries.

(a) *For Immediate Hæmorrhage.*—Ligature of the common trunk is here rarely called for, as above stated. In civil practice, such cases may occasionally occur in cut-throat. If the surgeon arrive in time, he should arrest the hæmorrhage, while waiting for assistance, by thrusting one or more fingers into the wound, and making pressure on the bleeding point, remembering that but slight force is required if the

pressure is on the right spot. If the patient has to be removed any distance, finger pressure must be kept up, or the wound plugged with a sterilised sponge or aseptic gauze, and the head kept rigidly still. Pressure with a finger, or with a sponge on a holder should be kept up on the bleeding point while the wound is enlarged, and the opening in the carotid secured by ligatures placed above and below it.

Mr. Butcher, in a case of suicidal cut-throat implicating the common carotid, successfully ligatured the artery above and below, the patient making an excellent recovery.

While on this subject, I may refer to the following case of Mr. Guthrie's (*Wounds and Injuries of Arteries*, p. 78), which shows that if the carotid is wounded, though not opened, it is best to apply ligatures above and below.

In a case of attempted suicide, the cut was deepest on the left side, having laid bare the left carotid and wounded the internal jugular. "The opening into the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and, drawing them together, passed a single silk thread around so as to close the opening without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and, after due consideration, it was presumed that this wound might heal without requiring a ligature to be placed upon the artery. On the eighth day arterial hæmorrhage took place, and, on opening the wound, it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common into the external and internal carotids. The hæmorrhage ceased on placing a ligature on the external carotid, and, as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness." At the necropsy the internal jugular was found pervious, and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about a quarter of an inch with a soft clot, the wound in the common carotid was exactly below its bifurcation, and Mr. Guthrie thought that the ligature on the external carotid might have been sufficient.*

Mr. Guthrie mentions (*loc. supra cit.*, p. 79) another case in which the common carotid was wounded by a penknife, and the hæmorrhage arrested by tying the vessel above and below the wound.

(b) *For Secondary Hæmorrhage.*—A remarkable instance of punctured wound of the common carotid in which the vessel was tied for secondary hæmorrhage, in the pre-Listerian era, is thus recorded by Mr. Durham (*System of Surgery*, vol. i. p. 739):—

A child, aged 9, was wounded with glass, owing to an explosion of hydrogen gas. When admitted into Guy's Hospital, under the care of Mr. Hilton, the child was cold and blanched, but the bleeding, which had been profuse, had entirely ceased. There was a wound about an inch long "in the left carotid region." On the eighth day after the accident hæmorrhage recurred, and the common carotid was tied. Nine days later slight bleeding took place, but was arrested by plugging the wound with sponge.

* This would appear very doubtful, owing to the freeness of the collateral cerebral circulation, and the readiness with which a reflux current along the internal carotid is established.

Repeated epistaxis occurred, which weakened the child perceptibly. The sloughs became very offensive, but there was no further bleeding from the wound for eighteen days, when a considerable quantity was lost. The child gradually sank, and died six weeks after the accident.

At the necropsy the common carotid was found to have been traversed by a sharp-pointed fragment. Behind the wounded vessel was an abscess implicating the sympathetic. Mr. Durham thought that if a ligature had been applied on the distal as well as on the proximal side the child's life would have been saved.

Another case of secondary hæmorrhage has been recorded by Mr. Rivington (*Trans. Med.-Chir. Soc.*, vol. lxi. p. 63). This paper, like several others by the same writer, is replete with valuable information and interesting facts. It is an excellent instance of the way in which the carotid may, at any time, be wounded from within, and not from outside, by a foreign body penetrating the pharynx.

A boy, aged 9, six days after swallowing a small plaice-bone, was admitted into the London Hospital with stiffness and tenderness of the neck, a small tender lump on the left* side opposite to the cricoid cartilage, profuse salivation, and inability to swallow solid food. On the ninth and the eleventh day hæmorrhage took place, on the latter occasion to half a pint. The following account of the operation by which the injured vessel was found and secured will be most instructive to every operating surgeon, owing to the difficulties which presented themselves.

An incision was made along the edge of the sterno-mastoid for several inches. The muscle was found glued to the subjacent parts by recent adhesions. Above the anterior belly of the omo-hyoid was a dark patch about the size of a fourpenny piece, caused by extravasated blood looming through the fascia. The fascia over the large vessels being divided, a probe was passed down into a cavity containing clot hollowed out behind the vessels and on the inner side. Owing to the uniform discoloration of artery, vein, nerves, fascia, and areolar tissue by the extravasated blood, the structures met with, being all dark and equally stained, could scarcely be recognised. The descendens noni could not be seen, nor the vagus distinguished, though carefully looked for. More clots being turned out from the cavity, in one of these the fish-bone was found. A gush of blood which took place, evidently from the distal end, was arrested partly by pressure and partly by pulling forward the vessels with a blunt hook. The wounded vessel being found, a ligature was passed closely, as was thought, around it, both above and below the seat of injury. Owing to the danger of subjecting the patient to a further loss of blood, there was no time to make a prolonged dissection, and it was thought prudent to divide the artery at the seat of the wound to make sure that no branch was given off between the ligatures. When this was done, some nerve-fibres were recognised on the cut section, and the question arose whether these were the descendens noni or the vagus. As they were in front of the vessel, closely adherent, and apparently scarcely numerous enough for the vagus, it was concluded that they belonged to the descendens noni, and no attempt was made to disengage the nerve or to unite its extremities. It was proved, later on, that this nerve was the vagus, which, instead of lying between and behind the artery and vein, took, or had been pressed into, an unusual position in front of the artery, and, owing to the inflammation induced by the injury, had become firmly adherent to the vessel for some little distance above and below the aperture in the artery. Externally the nerve was stained of the same dark colour as the artery, and only in the centre, after section, were the white nerve-fibres to be recognised. The patient died ten days after the operation, having shown no evidence of ill effects from the divided vagus, save perhaps slight cough and difficulty in swallowing. Two gangrenous abscesses in the left half of the brain, which were probably already in progress prior to the operation, were the cause of death.

* The left common carotid is more exposed to danger in these cases from the passing of the œsophagus somewhat to this side.

(c) *Division of the Common Carotid* by gunshot injuries is usually fatal at once, as in two cases recorded in *Circular No. 3* of the War Department, Washington, 1871.

2. In aneurysm of the carotid. When an undoubted* aneurysm of this vessel exists, and is increasing in spite of pressure,† or where this cannot be made use of, the artery should be tied, on the cardiac side of the aneurysm if possible, or, failing this, distally.

The mortality after ligature of the common carotid for aneurysm has been hitherto high. Thus Mr. Johnson Smith (*loc. supra cit.*), quoting from the tables of M. Lefort,‡ gives twenty-one as fatal out of forty-seven cases of proximal ligature. Mr. Barwell§ considers a little over 25 per cent. to be the mortality in cases of aneurysm proper. Whichever of these estimates is correct, in the future the mortality should be much reduced by the advantages of aseptic surgery and modern ligatures. **The chief dangers** to be guarded against are suppuration of the sac and hæmorrhage, brain and lung complications, and hæmorrhage from the site of ligature. These are alluded to more fully below (p. 766).

The old operation for carotid aneurysm is described at p. 764.

Dr. Mendes, of Bahia, advocates (*Rev. de Chir.*, April, 1905) extirpation of ordinary aneurysm of the common carotid, and recites two cases in which this step was successful. In neither case is the report as full and precise as is usually the case with French surgeons.

The patients were 62 and 42. In the first the history was one of sixteen months. The aneurysm was as large as a mandarin, its upper limit apparently blending with the parotid. An incision having been made from the lobule of the ear to just above the clavicle, a preliminary ligature was placed around the lower part of the artery. The vagus was separated with difficulty from the sac. In the attempt to get above the upper extremity of the sac, which reached as high as the mastoid and appeared to enter the skull, a tear was made in the sac leading to profuse hæmorrhage, stopped at once by tightening the preliminary ligature. The account of the steps taken at this critical stage is brief and very obscure. A ligature was thrown round the upper part of the sac, and this was cut through 2 cm. below the ligature. The cut end was then closed by sutures. The sac must either have collapsed, or forcipressure must have been employed. The rest of the sac and the vessel down to the first ligature were then, presumably, removed. But no

* It is well known that this aneurysm is diagnosed more frequently than it is really found to exist, owing to the closeness with which a carotid aneurysm is simulated by some varicosity of the artery at its bifurcation, glandular and other tumours lying over it, and, in the root of the neck, other aneurysms—*e.g.*, of the innominate, aorta, and subclavian. Few surgeons will, I think, agree with the statement of Mr. Johnson Smith (*Dict. of Surg.*, vol. i. p. 235) that carotid aneurysm occurs "about as often as subclavian aneurysm, and with greater frequency than aneurysm of the axillary artery."

† This may be applied to the artery or the sac, or both. In the former case the artery should be compressed above the transverse process of the sixth cervical vertebra, to avoid making pressure on the vertebral at the same time. If pain, vertigo, sickness, &c., prevent a fair trial of digital pressure, an anæsthetic may be tried, but, as Mr. Barwell points out (*Encycl. of Surg.*, vol. iii. p. 498), there may be much difficulty in deciding how far the syncope, &c., which may be present are due to the anæsthetic or to the pressure. Another means of keeping up pressure on the common carotid is that suggested by Rouge, in which, the sterno-mastoid being relaxed, the surgeon insinuates his fingers behind one border and his thumb behind the other border of the muscle, and thus compresses the artery between them.

‡ *Gaz. Hebdom.*, 1864 and 1868.

§ *Loc. supra cit.*, p. 503

details are given on this point, nor whether the internal carotid was involved. The patient recovered and was well fourteen months later.

In the second case, which was of eleven months duration, the swelling, the size of a fist, occupied the upper two-thirds of the carotid region. The common carotid was tied low down, and divided between the ligature and a pair of forceps. A tear made in the internal jugular vein during the separation of the sac was sutured. Great difficulty was met with in getting above the upper end of the sac, which was intimately blended with the parotid. It is to be gathered that a ligature was finally placed above the sac, which reached, in this case also, as high as the mastoid. Here, again, no details are given where they are most needed. The patient recovered.

3. In aneurysm of the innominate or aortic arch. The question of the advisability of ligaturing the carotid, either together with the subclavian or alone, especially in the case of the left common carotid, is considered in the treatment of thoracic aneurysm (p. 811).

4. In orbital aneurysm, where the symptoms are becoming aggravated, or where pressure has failed, or where it cannot be endured, even intermittently, for a few minutes only at a time, and where galvano-puncture and injection of coagulating fluids are set aside owing to their uncertainty and riskiness.* It would probably be well to tie and resect any especially enlarged veins at the inner angle of the orbit at the same time (*vide infra*).

Of fifty-three cases (Rivington, *loc. supra cit.*), viz., twenty-one idiopathic and thirty-two traumatic, in which the common carotid was tied, thirteen of the former were cured, and seventeen of the latter. The above writer, speaking of this mode of treatment, says it is "at present the most successful and satisfactory means of treating orbital aneurysm. It should not be practised on patients advanced in years, or on those with heart disease, or evident atheromatous degeneration of arteries." The later statistics of Bodon, quoted by Dr. Murray (*loc. infra cit.*), confirm the success of ligature of the common carotid in this disease if the arteries are healthy. He collected in 1899 fifty-eight cases of traumatic exophthalmos treated by ligature of the common carotid. Twenty-six were cured, twenty improved, six were not improved, and six died chiefly from infective causes and hæmorrhage, conditions less likely to occur at the present time. Bodon also collected six cases in which both common carotids were tied without any deaths, and, with one exception, cure or improvement.

Dr. F. W. Murray reports a case with many points of interest (*Ann. of Surg.*, March, 1904). Thus, while the blow had been on the left side of the head, it is probable that both internal carotids had been ruptured, as the exophthalmos, &c., were marked on both sides. The left common carotid was tied three months after the injury, a step followed by great relief on both sides. A year and a half later the exophthalmos had reappeared, being most marked on the left side; the sub-conjunctival veins were engorged, and the supra-orbital vein was much enlarged. Pulsation had returned in the external carotid and superior thyroid arteries. Dr. Murray considered that this indicated

* Mr. Rivington (*Dict. of Surg.*, vol. ii. p. 131) speaks thus of injection: "It is more painful than ligature, and probably involves more risk to vision, as it may set up inflammatory mischief in the loose areolar tissue around the veins, which may spread to the cornea. It may also effect so much coagulation as to interfere with the requisite supply of blood for the maintenance of the ocular tissues."

complete return of the collateral circulation and increase in the pressure in the cavernous sinuses, and that it would have been wiser to tie the internal carotid. As in two cases of reappearance of the trouble resection of the branches of the veins at the inner angle of the orbit has been most successful, this step was advised, but declined by the patient.

5. In aneurysms of the external or internal carotid. These are very rare. Two cases of aneurysm of the former vessel have been published in recent years:

Mr. Morris (*Med.-Chir. Trans.*, vol. lxiv, p. 1) recorded one in which, after failure of ligature of the common carotid, the old operation of incising the sac was performed, and ligatures placed on the facial and lingual arteries, and upon the main trunk of the external carotid above the sac, with ultimate recovery.

The second case was published by Mr. Heath (*ibid.*, vol. lxxxiii, p. 69) in order to prove that ligature of the common carotid alone is sufficient to cure some cases of aneurysm of the external carotid.

The occurrence of aneurysm here in a woman, aged 23, was accounted for by the state of the cardiac valves and the liability for embolism to occur in consequence of detachment of a vegetation. There was a smooth, round, pulsating swelling just below the right mastoid process, reaching down to about the level of the upper border of the thyroid cartilage. It had the size and shape of half a small orange. The right tonsil was somewhat pushed inwards, the right temporal pulse was markedly weaker than the left, and the tongue deviated much to the right, the right half being a good deal wasted. The common carotid was tied, and the wound healed; pulsation in the aneurysm had stopped on the tenth day, and on the eighteenth the sac was smaller and quite hard. All seemed to be doing well till the thirty-third day after the operation, when loss of speech occurred somewhat suddenly, followed by right hemiplegia, and death on the thirty-fifth day, this being brought about by cerebral embolism taking place through the *left* carotid, the aneurysm being solidified throughout.

Aneurysm of the internal carotid is equally rare.

The following is a brief abstract of such a case (Dr. Wyeth, *Annals of Surgery*, August, 1887, p. 114), in which the common and external carotids were tied, together with the superior thyroids, successfully.

The internal trunk was affected with atheroma to such an extent that the ligature could not be applied to this vessel. The operation was performed July 24, 1883. The tumour rapidly diminished in size, the patient leaving the hospital on the twenty-ninth day after the operation. She was living and well four years after the above date.

6. In arterio-venous aneurysms. This matter has recently received additional attention from the origin of these aneurysms in wounds by small bullets of high velocity. The experience of Mr. G. H. Makins, C.B., on this subject has been already given (p. 168). In the *Journal of the Royal Army Medical Corps*, June, 1905, this authority gives the further history of five cases of the arterio-venous aneurysm of the neck, and draws the following conclusions: (a) A special difficulty met with in the neck is the exact localisation of the point of communication. Thus in the cases detailed in the above paper there was a doubt in one whether the common carotid or the inferior thyroid was the artery implicated, in another whether one or two of the carotids were involved, in two others the localisation to either the innominate or the subclavian had to be considered; and in the fifth case the innominate was allowed the carotid to be definitely fixed. (b) In considering a local operation, the risk of tying the common carotid is

of simultaneous ligature of both carotid artery and internal jugular has to be considered. (c) The extreme severity of the operation itself, as judged by recorded cases, seems to render the local incision of the aneurysm inadvisable, except under circumstances of extreme urgency. (d) Mr. Makins' "own view, therefore, is in favour of allowing time for the consolidation and contraction of the sac, and then the application of a proximal ligature when practicable, in all cases involving the great vessels of the neck." It is pointed out by Mr. Makins that the five cases illustrate the tendency to spontaneous cure exhibited by aneurysms resulting from wounds of healthy vessels. In the two in which a proximal ligature was applied to the common carotid, seven and six weeks after the injury, recovery was ultimately so complete that both the officers returned to active service.

7. In hæmorrhage caused by ulceration of the throat after scarlet fever.

This is a rare but most dangerous complication of ulceration of the throat, and is usually brought about either by sloughing of the soft parts, or, as in the case mentioned below, by the opening of an artery or vein into an abscess cavity.

My old friend Dr. Mahomed communicated a case to the Clinical Society (*Trans.*, vol. xvi. p. 21) in which this complication occurred in a patient aged 21. Secondary sore throat, after an ordinary convalescence, was noticed on the fifty-fourth day, with much swelling on the left side of the neck, followed by severe bleeding (to 40 ounces) from the mouth on the fifty-eighth day. The left common carotid was tied by Mr. Pepper on the fifty-ninth day. Five and a half ounces of pus were brought up soon after the operation, and the swelling of neck and pharynx subsided, a good recovery ultimately taking place.

The common carotid was selected for ligature in preference to the external, since it allowed the operation to be performed quite clear of the infiltrated tissues, and thus conferred a greater immunity from secondary hæmorrhage. Moreover, had the original bleeding come from the ascending pharyngeal, ligature of the external carotid might have failed to arrest it, as the place of origin of the former vessel is variable.

The next series of cases, 8 to 11, may call for ligature of the external carotid rather than of the common trunk. With reference to them it must be remembered that ligature of the common carotid must be resorted to, not, as has too often been the case, on account of the greater facility with which this vessel can be tied, but only when the state of the patient or the condition of the parts either primarily, from an anatomical point of view, or, later on, after secondary hæmorrhage, does not admit of tying the external carotid itself.*

8. In incised or punctured wounds near the angle of the jaw.

In these cases, as in those below, a correct diagnosis as to the vessel or vessels injured is by no means easy when a sharp weapon has passed obliquely and deeply behind the angle of the jaw. By such a wound the external or the internal carotid or some branches of the former aid open. A careful dissection can alone clear up the source

* In these cases the hæmorrhage may be arrested, and the dangers of tying the vessel avoided, by the temporary closure of this vessel by a loop of stout catgut.

of the bleeding, and, whenever it is possible, this should be resorted to; where the circumstances do not admit of this, the surgeon, relying upon the extreme rarity of injury to the internal carotid from its protected position,* will be abundantly justified in trying the external carotid. Ligature of the common trunk is less reliable, though, if resorted to on account of its simplicity, it may be defended by cases like those briefly alluded to by Mr. Le Gros Clark (*Lect. on Surg. Diagnosis, Shock, and Visceral Lesions*, p. 222), in which he successfully tied the common carotid for profuse arterial hæmorrhage due to stabs near the angle of the jaw:

"The injury was inflicted in the same way, and with the same form of instrument, in both instances—a pointed table-knife was plunged downwards and inwards behind the angle of the jaw. The bleeding was, in each case, controlled only by direct pressure with the fingers in the wound; and whilst this pressure was maintained I tied the artery. Not an untoward symptom accompanied or followed either of these operations."

On the other hand, cases of penetrating wounds near the angle of the jaw, ending fatally from hæmorrhage after ligature of the common carotid, will be found published by Mr. Travers (*Med.-Chir. Trans.*, 1827, p. 165), and Mr. Partridge (*Lancet*, 1864, vol. i. p. 659).

9. In punctured wounds through the mouth.

Here, too, the common carotid has been tied in some cases successfully, while in others this step has been followed by repeated hæmorrhages and death.

The following case may be quoted as an instance of the former result:

A child fell while holding the sharp end of a parasol in his mouth, the point being thrust forcibly to the back of the fauces and very nearly coming through the skin at the side of the neck. Considerable hæmorrhage occurred at once, and also about a week later. Ten days later a gush of arterial blood followed on coughing. The common carotid artery was tied, and the case ended successfully.†

On the other hand, cases ending fatally after ligature of the common carotid for hæmorrhage following punctured wounds of the mouth will be found recorded by Mr. Vincent,‡ Mr. Arnott (*Lancet*, 1864, vol. i. p. 135), and Mr. Marrant Baker (*St. Barth. Hosp. Rep.*, 1876, p. 163).

10. In hæmorrhage from carcinoma of the mouth—*e.g.*, tongue or fauces.

* Mr. Cripps (*Med.-Chir. Trans.*, vol. lxi. p. 235) shows that, out of eighteen cases in which the bleeding vessel was identified, the internal carotid was found only to have been wounded twice alone, and once in conjunction with the external.

† The case was under the care of Mr. Johnson at St. George's Hospital. It is quoted by Mr. Durham (*Syst. of Surg.*, vol. i. p. 745).

‡ *Med.-Chir. Trans.*, vol. xxix. p. 38. In this case the bifurcation of the right common carotid had been punctured by a bit of broken tobacco-pipe from within the mouth. Sloughy cellulitis set in, and hæmorrhage took place from the mouth a week after the accident. This was arrested by ligature of the common carotid, but recurred on the second, and again, fatally, on the fifth day after the operation. Mr. Vincent points out that if the bit of tobacco-pipe had been discovered and removed, fatal hæmorrhage must have followed instantly, as the artery was not only wounded, but plugged, by the foreign body.

This subject is alluded to at p. 746. It would be better surgery to tie the lingual in the case of tongue cancer, or, if the growth be farther back, to deal with the external carotid (p. 772) and ascending pharyngeal, and, only if this be found impossible, to ligature the common trunk.

11. In hæmorrhage after removal or incision of tonsils (p. 475), or from an abscess about a tonsil.

These cases are infrequent, but, when they do occur, are, in a large proportion of instances, most dangerous. The sources of the hæmorrhage are very numerous, viz.:—(1) one of the tonsillar arteries; (2) the tonsillar venous plexus; (3) the ascending pharyngeal; (4) the internal carotid. Hæmorrhage from the last two is much more likely to occur in suppuration in or around the tonsil than in wounds inflicted during operation on it.

The following is a good instance (Mr. Pitts, *St. Thomas's Hosp. Reports*, vol. xii. p. 131) of a tonsillar abscess proving fatal from hæmorrhage:

A man, aged 39, was admitted with severe tonsillar abscess, which soon burst with the escape of a little blood. About 16 oz. were lost on the third day, bleeding again recurring on the fourth and fifth. The left common carotid was now tied; thirty hours afterwards 22 oz. were lost, and the patient died.

There was an abscess cavity around the left tonsil which communicated with the left internal carotid by an opening the size of the little finger-nail.

Mr. Marrant Baker has recorded a case of suppuration around the tonsil dating to an injury.

Here the vessel injured was the ascending pharyngeal, but too short a time elapsed between the ligature of the common carotid and the death of the patient to say whether the operation would have been successful.

A man, aged 23, was admitted with symptoms of acute tonsillitis, the parts being tense, elastic, and prominent at one spot. A puncture was only followed by the escape of blood. The patient now gave a history of having fallen two days before, when drunk, and having grazed his throat with a clay pipe; this had been followed by very little bleeding. The temperature went up to 105°, and arterial hæmorrhage occurred on the third day after admission. A probe passed through the puncture showed that a considerable cavity existed; this was plugged with lint soaked in tr. ferri perchlor. The next day hæmorrhage recurred to half a pint; when ether was given, the bleeding again came on, nearly suffocating the patient. On exploring the cavity with a finger-tip, a bit of clay pipe was withdrawn; the cavity was again plugged and the common carotid tied. The patient died, without rallying, three hours later. A wound was found in the ascending pharyngeal artery.

Given a case of hæmorrhage from the tonsil (whether from a wound or an abscess) which resists other treatment,* including well-applied pressure kept up with a padded stick inside the mouth and a finger behind the angle of the jaw, and the use of one or two sutures (p. 475), the surgeon should tie the external carotid as low down as possible, placing a ligature on the ascending pharyngeal as well, if this vessel can be identified. If the bleeding is from one of the tonsillar vessels

* Every care should be taken throughout to keep the wound in the tonsil as aseptic as possible. As bearing on the use of iron perchloride as a styptic, see some remarks at p. 745.

it would be thus arrested; only if these steps fail should the common trunk be tied.

12. In hæmorrhage after operations on the neck or jaw. In hæmorrhage secondary to gunshot injuries.

In both these cases the parts may be so altered that it is quite impossible to find the bleeding point, and the soft parts may be so damaged, matted together, &c., that the surgeon may be driven to tie the common carotid, and to trust to this, and to plugging the wound, rendered as aseptic as possible, with strips of sterilised iodoform gauze,* and firm pressure over all.

13. To arrest the growth of aneurysm by anastomosis on the side of face, head, and neck.

The treatment of this condition is discussed at p. 769. It will be shown there that ligature of the external carotid cannot usually be looked upon as sufficient without other measures, owing to the free anastomosis between the branches of the opposite vessels. Still less is ligature of the common carotid likely to be successful, and this step should only be resorted to when ligature of the external carotid is impossible from the disease extending too low down; when, from its creeping towards the orbit, or to the back of the upper jaw, it is probable that there is a free anastomosis between the branches of the external and internal carotid through the ophthalmic; or when the ascending pharyngeal is sure to be involved, but this branch cannot be separately ligatured.

14. To arrest the progress of malignant growths which cannot be operated on, or which are recurrent, and which derive their blood supply from the internal as well as the external carotid.

This operation, first performed by Mott, is a very proper one in cases of malignant disease of the antrum, nose, &c., where the growth cannot otherwise be attacked and is increasing very rapidly, causing frequent bleeding, intense pain, and threatening to interfere with deglutition and respiration. The surgeon must be prepared for a good deal of sloughing, fætor, &c., as well as shrinking in very vascular growths which have begun to fungate. In this case, also, it will be a question as to whether it is wiser to ligature both external carotids or the common carotid. The cases given at pp. 762 and 772 will help here. If the common carotid is tied, the opposite external carotid should be ligatured also at the same time, owing to the free anastomosis, which will bring blood over from the opposite side. In any case it should be an operation to be performed at the patient's request after the matter has been explained to him, in the hope that its performance may lead to relief from the urgent local symptoms of the growth, and that life may be brought to a close, after an interval of relief, by increasing, but less painful, asthenia.

LINE.—From the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

GUIDE.—The above line and the inner edge of the sterno-mastoid.

RELATIONS.—The common carotids, as far as their relations in the neck go, extend from the sterno-clavicular articulation to the upper border of the thyroid cartilage, along a line from the above joint to a point midway between the jaw and the mastoid process.

* These may first be soaked in formalin solution (1 in 500) or in turpentine (p. 745).

IN FRONT.

Skin ; fasciæ ; platysma ; superficial branches of transverse cervical nerve, and anterior jugular.
 Sterno-mastoid, sterno-hyoid, sterno-thyroid, omo-hyoid ; sterno-mastoid artery.
 Superior and middle thyroid veins, and often a communicating branch between anterior jugular and facial veins, along the anterior border of sterno-mastoid.
 Descendens cervicis, usually on the sheath, sometimes within it.
 Anterior jugular vein (below).
 Sheath.

OUTSIDE.

Internal jugular (closer on left side).

INSIDE.

Pharynx.
 Larynx.
 Trachea.
 Thyroid gland and vessels.
 Recurrent laryngeal.

Common carotid.

BEHIND.

Rectus capitis anticus major.
 Longus colli. Scalenus anticus.
 Inferior thyroid artery and recurrent laryngeal.
 Vagus.
 Sympathetic.
 Sheath.

Operation.—Two sites are usually described, according as the vessel is tied above or below the omo-hyoid.

A. ABOVE THE OMO-HYOID (Fig. 269).—Also known as "the seat of election," owing to the greater facility with which this operation is usually performed.

The parts being sterilised, the shoulders are sufficiently raised, and the chin at first drawn a little upwards, while the head is turned to the opposite side,* so as to define the anterior border of the sterno-mastoid.† The surgeon, standing usually on the same side, makes an incision about three inches long, with its centre opposite to the cricoid cartilage, in the line of the artery, through the skin, platysma, and fasciæ, exposing the anterior border of the sterno-mastoid. Any superficial veins are now drawn aside, or tied, before division, with double ligatures. The deep fascia at the anterior border of the sterno-mastoid

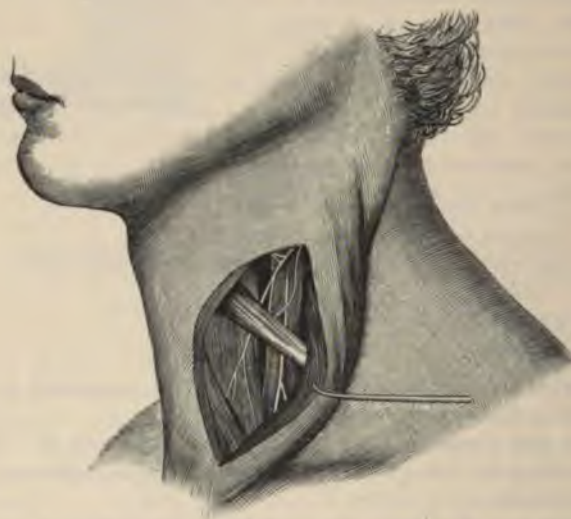
* Turning the head strongly to the opposite side should be avoided, as it brings the muscle over the artery. Mr. Barwell (*Encycl. Surg.*, vol. iii. p. 498) gives the following practical hint: "In certain aneurysmal cases (aortic and innominate) the etherised patient cannot breathe while his head is thrown back; the anaesthetiser is obliged to insist on bending it forward, and the operator has to get at the vessel under very trying circumstances, since in that posture it lies much deeper, and the ramus of the jaw is terribly in the way."

† Not always easy on the dead subject, or when the parts are infiltrated, as in Mr. Vincent's case (footnote, 756), or in Mr. Rivington's (p. 751).

is now divided, and the cellular tissue beneath opened up, usually bringing into view the upper border of the omo-hyoid, which, if in the way, is drawn down with a blunt hook, or divided. The edge of the sterno-mastoid is now drawn outwards, and the pulsations of the artery felt for just below the omo-hyoid.* In clearing the tissues which remain over the vessel, troublesome hæmorrhage may arise from the superior and middle thyroid veins, especially if the respiration be embarrassed; more rarely the sterno-mastoid artery is cut, and requires a ligature. The sheath is next exposed, and opened well to the inner side, avoiding the descendens cervicis, which usually lies to the front and outer side of the sheath.

Other difficulties which may now be met with are an enlarged thyroid lobe overhanging the artery or overlapping of it by the

FIG. 269.



Surgical anatomy of the common carotid. (Maunder.)

internal jugular when much distended. The coats of this vessel are so thin that, if it be much swollen, it is easily punctured, the result being that the wound is flooded with blood. It is best avoided by opening the sheath well to the inner side, but, if it still give trouble, it should be drawn aside with a blunt hook, or pressure should be made on it by an assistant, in the upper angle of the wound. If it should be opened, firm pressure should be made on this spot with a sponge on a holder, and the artery tied at a fresh place above or below. As soon as the ligature is tightened the hæmorrhage will cease, and firmly applied pressure outside the wound for forty-eight hours will suffice to prevent any recurrence. If, after wounding the vein, attempts be continued to tie the artery at the same place, the wound in the vein is almost certain to be made larger. Other methods are to take up the wound in the

* If the bifurcation be a low one, that vessel is chosen which on compression is found to be connected with the disease or injury.

vein with a tenaculum and secure the opening (if small) with a purse-string or other sutures of fine sterilised silk. If these fail, or in the case of a larger wound in the vessel, this should be secured between double ligatures. See also "Treatment of Injuries of the Femoral Vessels" (Vol. II.).

The sheath having been opened well to the inner side with a careful nick of the knife, the artery is now cautiously and sufficiently cleaned, the inner edge of the sheath being held with forceps while this side of the vessel is cleaned, and then the outer in the same way, and, finally, the posterior aspect, the point of Watson Cheyne's director being kept most scrupulously in contact with the vessel here.* The needle is then passed from without inwards, being kept most carefully close to the artery, especially behind, so as to avoid including the vagus.

In this, as in every other artery whose relations are important, the fewer of these relations that the surgeon sees the more masterly and successful will his operation be.

In a deeply lying artery, in addition to relaxing the parts by flexing forward the head and depressing the chin, the sterno-mastoid must be drawn outwards and the larynx inwards with retractors, while the omo-hyoid is drawn downwards with a blunt hook or divided. The pulsation of the artery is then felt for, or, where this is feeble or absent, the rolling of the artery as a flat cord under the finger is made out.

B. LIGATURE BELOW THE OMO-HYOID.—Here the artery lies much deeper, and has the recurrent laryngeal nerve behind it; on the left side, the internal jugular vein lies very close to the artery; on the right, there is a distinct interval between the two vessels.

The patient's head and the operator being in the same position as at p. 759, an incision three inches long is made in the line of the artery, from below the cricoid cartilage to just above the sterno-clavicular joint, exposing, as before, the anterior edge of the sterno-mastoid. This is drawn outwards, and, if needful, divided or detached below by making a short incision outwards along the clavicle. In this case the anterior jugular vein must be carefully looked for as it passes outwards in the root of the neck under the sterno-mastoid. The depressors of the hyoid bone next come into view; of these the sterno-hyoid, overlying the broader sterno-thyroid, is certain to be seen. If the omo-hyoid is coming up at this level, it lies external to the others. In such case it is to be drawn out while the other two are pulled inwards, any of the three being divided, on a director, if needful. At this stage one or more of the inferior thyroid veins may come into view, much swollen. The pulsation of the artery being felt for, or the flattened artery felt slipping beneath the finger when pressed upon, the sheath is to be opened well to the inner side, retractors usually being required at this stage. Care must be taken of the internal jugular, especially on the left side, as, if distended, it may conceal the artery.

When the carotid is sufficiently cleaned, the needle is passed from without inwards, avoiding the recurrent laryngeal nerve behind by keeping very close to the artery.

* Opening the sheath on the inner side and cleaning the vessel properly are the two best safeguards against accidents. For a hint which may be helpful in recognising the artery on the dead subject, a footnote (p. 765) may be referred to.

Temporary Ligature of the Carotid.—Mr. Rivington (p. 768) and Sir F. Treves (*Lancet*, Jan. 27, 1888, p. 111) have drawn attention to this method, believing that the ligature of main arteries is resorted to too often, as there is sufficient evidence to show that in most cases it is only temporary arrest of the current that is required.

This method should certainly receive a further trial, on account of the risks of cerebral mischief after ligature of the carotid, and also because, as Sir F. Treves says, pressure upon the carotid cannot be successfully maintained for a serviceable length of time.

The artery being exposed in the ordinary way, a thick piece of soft catgut is passed round it and tied in a very loose loop. By pulling on the loop, the blood-current is at once arrested, and restored when the tension is relaxed.

The following are abstracts of the four cases given by Sir Frederick :

1. Probable Wound of Superior Thyroid Artery.—A young man was admitted with a deep, profusely bleeding wound about the level of the great cornu of the hyoid. A fragment of glass driven in by a bursting soda-water bottle had been removed. The patient was blanched and almost insensible. It being "obviously useless to attempt to find the bleeding point while blood was welling up from so deep a wound," a temporary ligature was placed round the common carotid. Traction on this arrested all bleeding, and was maintained for half an hour. On relaxing the catgut, no hæmorrhage occurred. The loop was left *in situ* for four days, and then removed. The bleeding was supposed to come from the superior thyroid.

2. Hæmorrhage from Internal Carotid.—A child, aged 3, had profuse hæmorrhage from the right ear, and vomited blood. This recurred, and the right common carotid was ligatured, when the bleeding ceased. The next day hæmorrhage recurred, blood having evidently been brought round by the left carotid. As there is no case on record* of

* I am indebted to Dr. Simpson, Surg.-Capt. Ind. Med. Service, for the following very interesting case, which has an important bearing on the above statement :—Case of Resection of the Right Upper Jaw for Sarcoma, with Ligature of both Common Carotids.—The patient was a Telugu lad, about 18 years of age, admitted into the Madras General Hospital while Dr. Simpson was acting as surgeon. Prior to the resection the right common carotid was tied with the view of diminishing the hæmorrhage at the operation. One week elapsed between the ligature of the artery and the removal of the jaw. During that interval Dr. Simpson and Dr. Smyth came to the conclusion that there would be no immediate danger in occluding the other common carotid, if need arose. Dr. Simpson began the operation (on the eighth day after ligature of the right carotid) by exposing the left common carotid at the level of the cricoid and passing a piece of elastic tubing round it. This was tightened gently, and produced no effect upon the patient, who was well under the influence of chloroform. With the assistance of Dr. Smyth, Dr. Simpson removed the jaw, this being done almost bloodlessly. On relaxation of the tubing, sharp hæmorrhage ensued. In preference to attempting to arrest this, and thus causing much delay—a matter of great importance—a ligature was substituted for the tubing, and the artery was tied. The patient made an uninterrupted recovery, and six months later was known to be in good health. There seemed danger at first of sloughing along the lines of separation of the jaw, and irrigation was constantly employed for the first two or three days. The case will be found published in the *Trans. South Ind. Branch Brit. Med. Assoc.*, vol. v., No. 3.

Dr. J. T. Thomas published a somewhat similar case, ending less favourably, in which both common carotids were tied, with an interval of about two months, under conditions of much interest. The right trunk was tied, under local analgesia by the Schleich method, to afford relief for an inoperable sarcoma of nose, orbit, and mouth. "A slow but positive improvement followed the operation, shown by the diminished frequency of the hæmorrhages from the nose, marked relief from pain in the head, and general comfort of the patient. The mass diminished perceptibly in size." As in two months the hæmorrhages and pains in the head were recurring, it was determined to tie the left external carotid. The usual operation was performed under cocaine on this side; the point of division of the common carotid was so high that the external carotid could not be found. As the patient's condition did not admit of further prolongation of the operation, the left common carotid was tied. Death, preceded by coma, followed in a few hours.

recovery after ligature of both common carotids when the interval between the occlusion of the two vessels was less than some weeks, Sir F. Treves simply placed a loop of catgut round the left carotid, and had traction made on it. The child never bled again, but sank exhausted six days after the second operation.

3. Hæmorrhage probably from External Carotid, after Impalement with a Spike.—A man, aged 41, fell twenty-six feet upon a railing-spike, which, entering just in front of the left ear, passed through the upper jaws, and entered the mouth through the hard palate on the right side. After removal of the spike, blood welled up freely from the wounds and nose. Traction made on a catgut loop passed round the left common carotid arrested this. A weak pulse could be felt in the temporal on the fourth day, and on the seventh the loop was removed. The case did well. It is not stated how long traction was maintained.

4. Hæmorrhage during an Operation.—In this case the loop was placed around the artery prior to removing a large malignant tumour of the neck. Very free bleeding occurred during the operation, but was always checked by traction on the loop. Without this the operation would have been very difficult.

Dr. G. Crile, of Cleveland, U.S.A., recognising, as we all do, the limit of safe range in the severer operation on the head and neck due to hæmorrhage, the immediate blood loss, later infective pneumonia, and the fact that, while permanent closure of the external carotids is permissible, that of the common is attended with much risk, has devised experimentally and carried out successfully the **temporary closure of the carotids by special clamps** (*Ann. Surg.*, vol. xxxv., 1902, p. 441).

The technique is as follows. In cases where the trunks of the vagi or their superior laryngeal branches are likely to be interfered with* one hundredth of a grain of atropine should be injected twenty minutes previous to making the incision, in order to prevent possible inhibitory action upon the heart. The artery is closed by small clamps with blades protected by india-rubber and capable of delicate and accurate closure by a screw. Surgeons of this country will at once recognise their close similarity to Mr. Makins's intestinal clamps. In operations in which blood may enter the air passages, Trendelenberg's position should be employed. This partially makes up for the lowered cerebral blood-pressure which results from closure of the carotids, while, from the cases published, it does not appear to increase the venous and capillary hæmorrhage to any material degree. In applying the clamps the walls need only to be approximated, not compressed. This is effected by the delicate control of the screw, and by keeping the blades exactly parallel with each other. Dr. Crile's experiments on nineteen dogs showed that a clamp properly adjusted could be left in position, in the absence of infection, from twenty-four to forty-eight hours, without serious injury to the artery. The release of the clamp should be made slowly, the field of the operation being carefully inspected for any vessels which may have been overlooked. When the Trendelenberg position has been employed it is safer to restore the patient to the horizontal position before releasing the carotid. Sixteen cases are given which in severity were well calculated to test Dr. Crile's method. They include cases of removal of epithelioma of tongue, floor of mouth and glands, growths of the parotid, removal of upper jaw, congenital growths, nævoid and other, of neck and orbit. Both common carotids were closed in ten cases. There were no deaths attributable to the method. The ages of the patients varied from seven months to sixty-nine years. In every case the circulation was resumed at once on the release of the clamps. There were no appreciable effects on the vessel walls, and no later cerebral effects. Less anæsthetic was necessary with closed arteries, especially in the cases in which the common carotids were closed. In the latter case there may be embarrassed breathing, especially later. Wholly or partially releasing one or both carotids gave material and immediate assistance. The time occupied was much diminished, as the field of operation was quite bloodless. The amount of blood lost was strikingly less, as was also the difficulty in keeping blood from the respiratory tract. The application of the clamp is easily accomplished, the incision being prolonged if needful for removal of glands, &c.

* In two cases where, in spite of injection of a hundredth of a grain of atropine, manipulation of the vagus caused the pulse to fall from about 90 to 56, the packing of 2 per cent. solution of cocaine around the nerve led to a prompt return of the pulse to its previous rate.

Old Operation for Ligature of the Common Carotid.—This, one of the most formidable operations in surgery, was successfully made use of by Prof. Syme (*Observ. in Clin. Surg.*, p. 154) in a case of aneurysm the result of a stab.

The aneurysm, about the size of an orange, extended between the trachea and sterno-mastoid, and downwards close to, or rather under, the clavicle. Nearly at its centre was a cicatrix. It was increasing in size, and, other treatment having failed, it was decided to perform the old operation, it being evidently impossible to apply a ligature below the aneurysm.

"I pushed a knife through the cicatrix, and followed the blade with the forefinger of my left hand so closely as to prevent any effusion of blood. I then searched through the clots and fluid contents of the sac for the wound of the artery, and found that pressure at one part made the pulsation cease. Keeping my finger steadily applied to this point, I laid the cavity freely open both upwards and downwards, turned out the clots, and sponged away the blood so as to get a view of the bottom, which presented the smooth, shining aspect of a serous membrane, without the slightest indication of either the artery or vein that could be seen or felt. In order to make the requisite dissection, I next attempted to close the orifice by means of forceps, but found that it had the form of a slit, which could not be thus commanded. It was also so near the clavicle that pressure could not be employed below it, and, to my still greater concern, lay on the inner or tracheal side of the vessel, so that the compression required for its closure, instead of being backwards on the vertebrae, was outwards upon the vein. In these circumstances it seemed proper, so far as possible, to lessen the opposing difficulties, and I therefore ran a bistoury through the skin and the sternal portion of the sterno-mastoid. I then seized the edge of the slit in the artery, as it lay under my finger, with catch-forceps, and desired them to be held so as to draw the vessel towards the trachea; I then carefully scratched with the point of a knife until the arterial coat was brought into view at its external edge, a little above the aperture, where a ligature was passed by the needle, and tied. I repeated the same procedure below the wound, and, when it was completed, had the satisfaction of finding that my finger could be withdrawn without the slightest appearance of bleeding, instead of the tremendous gush which had previously attended its slightest displacement. The ligatures separated on the tenth day, and the patient recovered completely."

Prof. Syme considered this by far the most arduous operation he had undertaken, from the fact that "the slightest displacement of one hand must have instantaneously caused a fatal hæmorrhage from the carotid artery, and a wrong direction of the needle by the other, to the smallest possible extent, would have given issue to an irrepressible stream from the jugular vein."

Sir J. E. Erichsen* gives the following graphic picture of the difficulties of the operation:

"The hæmorrhage having been completely arrested, either by compression of the artery above the tumour, or by pressure of the fingers at the opening leading into the tumour,† you lay it open freely and completely, turn out the coagula, and syringe away any dark or fluid blood which may be there. You then open the interior of the aneurysm. But what is that interior? It is not the interior of a smooth sac, but it is a large ragged cavity, with masses of coagulum or solid fibrin sticking to it in different directions, with the remains, perhaps, of an old, sacculated aneurysm at the bottom, with a quantity

* *Lancet*, 1868, vol. ii. p. 505.

† Sir John thus puts Prof. Syme's practical point: "to make a small opening into the tumour, an opening just sufficient to enable you to insinuate your fingers, and so to work your whole hand gradually into the tumour in that way, so that the entrance of the hand may plug up the opening into the sac; to feel with your fingers for the opening into the artery, and to get your fingers against that, so as to restrain the flow of blood from it, before the rest of the sac is laid open."

of plastic matter infiltrating the tissues around it, with the anatomical relations of the parts utterly and completely disturbed and destroyed, with great thickening and solidification of the parts around from the pressure to which they have been subjected in consequence of the effusion of plastic matter. So you have a large cavity with an opening at the bottom of it, the opening leading to the artery somewhere or other, but the position of the artery more or less disturbed, more or less masked and obscured by these masses of coagulum, by this plastic infiltration, by this thickening and cohesion of the tissues to one another around it. The next thing is to pass the ligature around the artery. Now, the artery does not lie exposed in this sac; quite the contrary. You have to scrape, or to dissect, or cut through the posterior wall of this sac, which always overlies the artery. That constitutes the great difficulty of the operation—to open up this posterior wall in a proper direction, and to get the needle round the part without wounding the contiguous vein, or transfixing the artery, or doing damage to the neighbouring parts. The best way of doing that, undoubtedly, is to introduce a large steel probe or a metallic bougie into the opening into the artery, and to use that as a guide to the situation of the vessel. You may use a large one, so as to plug up the opening.* . . . You then clear the vessel as well as you can—the coats are generally thickened and diseased in the vicinity of the aneurysmal tumour—and you pass a good double ligature around it."

Difficulties and Possible Mistakes during Ligature of the Common Carotid.

(1) Altered condition of the soft parts—*e.g.*, matted and œdematous from the close contiguity of an aneurysm, from a previous trial of pressure; or loaded with blood or inflammatory products, as in the case of a wound. (2) Presence of an aneurysm encroaching upon the incision. (3) Not hitting the edge of the sterno-mastoid. This muscle may be drawn over the artery if the chin be too much forced to the opposite side. The chin should be kept about midway between the acromion and the episternal notch on the opposite side (Barwell). (4) Great enlargement of the superior and middle thyroid veins.† (5) An enlarged and overlapping thyroid gland. (6) A large internal jugular overlapping the artery. (7) Opening the sheath towards its outer side, and so coming down upon, and perhaps injuring, the vein.‡ (8) Including one of the nerves§ in relation with the artery—*e.g.*, the descendens cervicis, the vagus, or the sympathetic (p. 751).

* In one case, as stated by Sir John, Mr. Birkett used a bougie as a guide.

† Mr. Barwell (*Internat. Encycl. Surg.*, vol. iii. p. 499) says that the superior thyroid vein, very full and turgid, sometimes runs before, more often behind, the carotid. "I suppose it is the effect of the anæsthetic which causes this to swell to the size of a cedar pencil."

‡ On the dead body, especially, there is a risk of mistaking the flaccid jugular for fascia, and opening it, unless the sheath has been opened over its front and inner part as should always be the practice. Another hint may be useful. In a body injected with formalin, owing to the clotting of the blood in the vein, this vessel may appear thick, and give the impression of an injected artery. The latter will be known by its white colour and empty condition.

§ "The descendens noni lies usually on the outer part of the sheath, and will rarely be endangered if that structure is opened as above described; but it is well to see that it is out of the line taken by the director; if its absence there be verified, it need not be hunted up elsewhere. The pneumogastric lies in the interval between the artery and vein in the back part of, but not loose in, the sheath; each of the vessels, as well as the nerve, has a compartment, strongly walled, to itself; while the sympathetic, behind the sheath, is also separated by a thick fascia from the vessels. If these anatomical positions be maintained, both nerves are saved. Young operators are sometimes made anxious and

Causes of Failure and Death after Ligature of the Common Carotid.

1. Cerebral complications—*e.g.*, impaired nutrition and softening. Sir J. E. Erichsen thinks that "cerebral symptoms" (he does not say whether he means fatal ones or no) are liable to occur in 25 per cent. of ligatures of the common carotid. They may come on almost at once, or some days after the operation. The same surgeon divides them into two sets: (1) the early ones, resulting from the too small supply of arterial blood, *viz.*, syncope, twitchings, giddiness, impaired sight, and hemiplegia; (2) after the above have been present for a few days, and softening has taken place, convulsions and death ensue. It would be, perhaps, worth while, in view of the above mortality, to try pressure before resorting to the ligature, in order that the opposite vessels may become enlarged. Pressure could only be kept up, without an anæsthetic, for a few minutes at a time, and care would have to be taken not to apply it at the intended site of ligature. The temporary ligature and Dr. Crile's method (pp. 762, 763) also deserve trial. 2. Infective complications. 3. Recurrent pulsation. In most cases this is due to blood finding its way round from the opposite side. The pressure, however, in cases of aneurysm, having been relieved, coagulation, as a rule, takes place, though slowly. In a smaller number of cases the recurrence of the pulsation has been of a more permanent kind, from the ligature becoming loosened or dissolved, especially when catgut has been used. 4. Suppuration of the sac. Sir J. E. Erichsen states that this is not very uncommon. "In the majority of cases the patient eventually does well." 5. Hæmorrhage. This has never been a common complication, owing to the absence of branches. It may take place from the site of ligature* or from a suppurating sac. It should be still more rarely met with in the future, owing to the modern treatment of wounds. 6. Low forms of lung inflammation. The above authority states that these are not uncommon. He attributes them to diminished freedom of the respiratory movements owing to the disturbed circulation in the brain and medulla.

LIGATURE OF THE EXTERNAL CAROTID (Fig. 271).

This operation has not received the attention which it deserves, having been too often set aside for the easier operation of ligature of the common trunk.

Mr. Cripps,† discussing the ligature of the external carotid in the treatment of hæmorrhage from punctured wounds of the throat and neck, states that the objections raised to the above operation are:

1. The fear of secondary hæmorrhage from the seat of ligature due to the close proximity of its larger branches.

embarrassed by unnecessary cautions, yet sometimes the parts do not quite maintain their proper positions. Hence it is well, before tightening the ligature, to see that it includes the artery only" (Barwell (*loc. supra cit.*)).

* This danger would seem to increase the lower down the ligature is placed. Mr. Barwell says that the only fatal case of secondary hæmorrhage he has had in this operation followed the ligature of a carotid with catgut close above the sterno-clavicular joint. It is not stated whether the wound was aseptic throughout or not.

† *Med.-Chir. Trans.*, vol. lxi. p. 234.

In answer to this he refers to M. Guyon's* collection of 27 cases of ligature of the external carotid, to which he adds 3. In only one case of these 30 did secondary hæmorrhage occur. Larger statistics than these have been furnished by Dr. Wyeth, of New York. He states that, of 67 cases in which the external carotid alone was tied, 3 died, and that all these fatal cases were from gunshot injuries in military practice. One of these fatal cases died on the table from the effects of hæmorrhage before the ligature could be applied. In the other two the cause of death is not given. Of the 67 cases, hæmorrhage occurred after ligature in 5, none of which proved fatal. In 4 of these the bleeding was noted as occurring at the seat of lesion beyond the ligature. The artery was tied on both sides in 2 patients, and both recovered.

Dr. Bryant, of New York,† states that he can add 16 cases to the above 67, and that in only one of these did the subsequent death bear the least relation to the operation itself.

As stated at p. 775, the branches adjacent to the seat of ligature should be tied also.

2. The futility of the operation should the wounded vessel be the internal carotid.

Mr. Cripps answers this objection by comparing the rareness of a wound of the internal carotid with one of the external or its branches.

He points out that, of 18 cases in which the bleeding vessel was identified, the internal one was wounded twice alone, and once in conjunction with the external.‡

3. The external carotid is less easy to ligature than the common.

This objection will not weigh with a surgeon who knows his anatomy, who is in the habit of operating, and who begins by exposing the vessel at the bifurcation of the common trunk.

The **advantages** of the operation are :

1. That the circulation through the brain is not in the least interfered with. Consequently one large element of danger is avoided (p. 766).

2. The incision made over the external carotid can also expose the bifurcation and the internal carotid, and may thus lead to a direct exposure of the wounded vessel.

Indications.

i. Wounds of the Trunk and of its Branches.—This subject has been already alluded to (pp. 755 *et seq.*). While it cannot be denied that the easier operation of ligature of the common trunk has answered in some of these cases, it has also certainly failed repeatedly. Considering the

* *Mém. de la Soc. de Chir.*, vol. vi. According to Prof. Agnew (*Prin. and Pract. of Surg.*, vol. i. p. 636), out of nineteen cases of ligature of the external carotid only one proved fatal from hæmorrhage, and none from causes which could properly be attributed to the operation.

† *Ann. of Surg.*, Aug., 1887, p. 122. In this fatal case both external carotids had been tied to check the rate of progress of malignant disease of the lower jaw, floor of mouth, and tongue, which had been operated on repeatedly without success.

‡ Mr. Cripps' list is interesting to the surgeon. In the first ten it is to be presumed that ligature of the external carotid would have been the wiser course. In two the bleeding came from the external carotid; in one, the lingual; in one, the facial; in one, a tonsillar branch; in one, a branch in the parotid gland; in two, the internal maxillary; in one, the inferior dental; in one, the middle meningeal; in one, the vertebral; in two, the internal carotid; in one, the external also was wounded; in one the source was close to the bifurcation; in two the common carotid, at the point of bifurcation, was wounded; in one, the ascending pharyngeal.

rarity of wounds of the internal carotid, the surgeon will do more wisely, in the case of a wound over the carotid area, to expose and tie the external carotid, low down in any cases of doubt, so that the trunk and the internal carotid may be exposed as well, if needful.

Mr. Rivington recorded (*Clin. Soc. Trans.*, vol. xvii. p. 79) an interesting case of a wound of the external carotid by a stab in the parotid region giving rise to recurrent attacks of hæmorrhage, and treated successfully by temporary* ligature of the common carotid and ligature of the external carotid at the seat of injury.

A man, aged 31, was admitted into the London Hospital with three wounds, one severing the lobule of the left ear and passing into the parotid gland below the zygoma, a second behind the ear, and a third over the mastoid process. Hæmorrhage, occurring

about a week later, was stopped by pressure. Erysipelas followed, and an abscess was opened in front of the ear. About three weeks after the accident hæmorrhage again occurred, being brought on by a fit of coughing, blood running out from all the incisions. Though it was again arrested by pressure, Mr. Rivington judged, from the size of the stream and the force of the jet, that the injured vessel must have been the external carotid in the parotid gland.

On account of the difficulty of securing the artery at the seat of injury, and the amount of blood which would be lost before this could be accomplished, and not being able to rely upon pressure on the common carotid during the operation, Mr. Rivington cut down first on the common trunk at its bifurcation and placed a temporary ligature of catgut round it,† tying this lightly so as to stop the current of blood, but not to divide the inner and middle coats.

The openings in the parotid region being explored and clots turned out, a little below the angle of the jaw was found

a hole from which some blood issued in a feeble stream. The external carotid was ligatured above and below this spot. The ligature in the main trunk was then untied, and left *in situ* for use if needed. All bleeding had ceased, and there was no recurrence. The patient made a good recovery, some weakness of the face muscles having almost disappeared when he left the hospital.

Mr. Rivington drew attention to the advantage of the temporary ligature on the main trunk, rendered very evident by the fact that immediately before the operation, when the sponge was removed, arterial blood spurted out in a lively jet, whilst after the ligature a languid stream only issued from the distal side of the hole in the external carotid. He further pointed out that the employment of temporary ligatures, either lightly tied or left *in situ* for use in case

* Some cases in which Sir F. Treves at a later date made use of this step are given at p. 762.

† It remained uncertain whether this temporary ligature was placed on the external or the common carotid.

FIG. 270.



(Fergusson.)

of need, is capable of wider application in the treatment both of hæmorrhage and of aneurysms.

ii. Aneurysm by Anastomosis of Scalp and Side of Head and Neck (Fig. 270).—Here the ligature of the external carotid is made use of as an adjunct to local treatment, or where this has failed.

If the growth is not too large, it should be excised with aseptic precautions, tying each vessel as it is cut. The operation may be rendered partly evascular by the use of sterilised india-rubber tubing passed round the back of the head and the lower jaw, with pledgets of gauze over the main vessels—*e.g.*, temporal or external carotid, posterior auricular, and occipital.

Where the above is not applicable, the external carotid may be tied preliminary to removing the tumour. When this is being effected, any skin that is not too much involved should be preserved. If this is impossible, the growth must be taken away, with the skin over it, the vessels being secured as cut. Every pains must be taken to keep the wound sterile, and thus promote rapid granulation-healing, completed by Thiersch's skin-grafting (p. 233).

As these cases are most obstinate, my readers will excuse me if I draw their attention to other cases, proving that ligature of the external carotid (even if performed on both sides) is not likely to be successful without local treatment as well—*viz.*, either underrunning the vessels with pins, or excision. It is recorded by Dr. Bryant, of New York (*Ann. of Surg.*, Aug., 1887, p. 116):

The patient, aged 24, had a well-defined pulsating tumour at the site of a healed scalp-wound in front of the left ear. The trunk and branches of the temporal and the occipital were concerned in the growth. As this was rapidly increasing, the left external carotid was tied with catgut about half an inch above its origin. Tying the lingual artery also provided a branchless portion of the external carotid about an inch in extent. The ascending pharyngeal was sought for, but not found. All pulsation was at once checked, and the growth was also reduced to about one-third of its previous size. The operation was antiseptic throughout, and when the dressings were changed, for the first time in ten days, a slight return of pulsation was noticed in the tumour. A month after the operation, pulsation, thrill, and bruit were nearly as strong as before, and it was decided to attack the tumour itself in preference to tying the occipital and temporal branches, or the right external carotid. The arterial circulation was admirably controlled by surrounding the head with two strong rubber bands, beneath which compresses were placed at the points where arteries passed to supply the scalp.

Dr. Bryant found on record eight other cases of ligature of the external carotid for the cure of aneurysmal tumours of the head, face, and parotid gland, in two of which both the vessels were tied simultaneously. This latter procedure is not reported to have been successful in either case. Of a total of nine cases, only one, a traumatic aneurysm of the parotid, was cured by ligature alone.

Thus it would appear that local remedies—*viz.*, excision and underrunning, aided by ligature of the chief feeding arteries—are most likely to be successful in this disease, which so often baffles treatment. Ligature of the external carotid, on one or both sides, will fail, owing to the free collateral circulation, if tried by itself, even in recent traumatic cases without much general dilatation of the vessels. If used at all, it should be as an adjunct and a preliminary step to diminish the vascularity of the tumour before this is dealt with locally by the methods above indicated.

Treatment of Vascular Growths by Injection of Boiling Water.—John A. Wyeth (*Journ. Amer. Med. Assoc.*, June 27, 1903) reports good results by this method.* While careful not to claim too much in the way of cure or to say that it is absolutely without danger, the author considers himself justified in recommending its employment. One case was that of a young woman suffering from a large angioma of chin, neck, and part of the submucous tissues of the mouth. Hunter, McGuire, and Wyeth had each previously attempted operation, but had been obliged to resist on account of the hæmorrhage.

Ether having been given and peripheral compression applied, about one-third of the growth was injected with from 2 to 3 oz. of boiling water. There was no necrosis of the mucous membrane, the patient suffered no pain, and there was no elevation of temperature. Two weeks later, the area injected became less than half its former size. Altogether three injections were made, resulting in the entire obliteration of the growth. Other cases are given in which the results were equally satisfactory.

One of these was a cirroid aneurysm covering about one-half of the left side of the scalp, where numerous ineffectual attempts had been made to arrest the growth. Here the needle was introduced along the course of five arteries which could be distinctly made out. Some œdema of the face and neck developed, and Wyeth is of opinion that obliteration of the whole growth at one sitting should not be attempted, though he has successfully employed this method in a number of cases of capillary angioma. Where the growth is superficial, the water should be injected beneath the growth and not into it, as some sloughing is apt to result unless the greatest care is taken.

Dr. W. J. Mayo in the discussion on the above paper referred to a case of very large angioma of the cheek which he had successfully treated by the injection of boiling water.

F. Griffith relates (*New York Med. Journ.*, May 2, 1903) a case of nævus of scalp and nose treated by Wyeth's method in an infant of 7 months. Here a number of injections varying from ten drops to a drachm were employed. The result was very satisfactory.

iii. Aneurysm of the External Carotid.—The treatment of this rare condition has been already discussed at p. 754.

iv. (A) As a Preparatory Step to Extirpating Malignant Growths of the Upper Jaw, Pharynx, &c., or (B) as a Palliative Step where the above extirpation cannot be attempted.

(A) As a preparatory step to extirpating malignant growths.—The external carotid may be tied before attempting to remove growths of the parotid, tonsil, upper jaw, angle of lower jaw, palate, or pterygoid region. The risk of secondary hæmorrhage is alluded to at pp. 613 and 722.

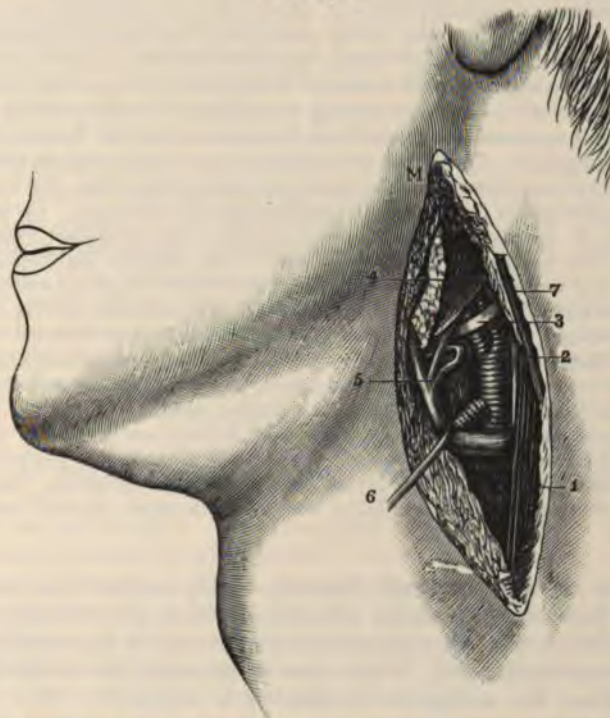
I have alluded at p. 577 to a case in which I have resorted to this step—one of a sarcoma of the palate and pterygoid region. The first patient is alive and well five years after the operation. In another case, epithelioma of the hard and soft palate, as four years had elapsed when the patient was last heard of, I am hopeful that he is cured. In 1900 I twice tied the external carotid before removing growths. One was a patient, æt. 66, sent me by Dr. Osborn, of Dover, with an ulcerating epithelioma on the inner aspect of the angle of the right jaw. The glands of the right submaxillary and deep cervical groups were also involved. Previous to removing the affected part of the jaw, the tonsil, and the glands, by an incision on the lines given at p. 612, I tied the external carotid. The patient died from gradual cardiac failure on the eighth day, and the necropsy, which proved that a fatty heart was the actual cause of death, also demonstrated the existence of a slough in the deeper part of the wound, so that, if the patient had lived longer, it is quite possible that secondary hæmorrhage would have supervened.

The second case was one of a girl of 16, on whom the late Mr. Davies-Colley had amputated through the lower third of the right thigh for a periosteal sarcoma of the

* Wyeth had previously proved that injection of boiling water into the iliac artery of dogs resulted in the immediate occlusion of the vessel and all its branches.

tibia. The disease reappearing in the thigh, I amputated at the hip-joint by lateral flaps, securing each vessel as they appeared (see section on Amputation at the Hip Joint). The patient made a good recovery from this operation, but three weeks later the left eyeball began to protrude, epistaxis ensued, and it was clear that a secondary deposit had invaded the orbit and was extending through the inner wall. I tied the common carotid on the left so as to shut off the ophthalmic artery, and then the external carotid on the left so as to prevent the blood finding its way round so soon as to render

FIG. 271.



Parts concerned in ligature of the left external carotid dissected :—M, Angle of the mandible. 1, Anterior border of sterno-mastoid. 2, Descendens cervicis. 3, Hypoglossal. 4, Posterior belly of digastric. 5, Lymphatic gland displaced from its position over the artery. 6, Venous trunk common to the superior thyroid, lingual, and facial, hooked downwards so as to show the spot to be chosen for the ligature, viz., between the origins of the superior thyroid below and the lingual and facial above. (These branches are drawn far too large.) 7, External jugular vein descending from the parotid gland in the upper angle of the wound. (Farabeuf.)

the ligature of the common carotid unavailing. Mr. Hilton, the house-surgeon, then cleared out the orbit. This step, including the removal of the eyeball and the sarcomatous mass which was making its way through the thin inner wall, was attended with very little bleeding. The eyeball was then packed with sterilised gauze wrung out of formalin, one strip being brought out at the nose through the inner wall. The wounds in the neck healed by first intention, and the ligatures gave no trouble whatever. The patient died, four months later, of secondary growths in the skull, vertebrae, and pelvis. During this period the ligature of the above-mentioned vessels kept the epistaxis well in check.

(B) As a palliative step where removal of such growths as those alluded to at p. 770 is impossible. On this point I would refer my readers to the remarks already made at p. 590.

The following cases (Dr. Bryant, *Ann. of Surg.*, Aug., 1887, p. 121) are of interest as bearing on this matter. In each of these cases repeated operations had been performed for removal of malignant disease involving the lower jaw, floor of the mouth, and more or less of the tongue. Rapid recurrence had taken place in each case, until, the use of the knife no longer appearing feasible, the only course seemed to be starvation of the growth. Accordingly this was attempted by simultaneous ligature of both the external carotids, by incisions in the usual place, the enlarged lymphatic glands found being removed. When the carotids were reached, most unusual anomalies were found. The right common carotid bifurcated beneath the posterior belly of the digastric, which was divided to admit of passing the ligature. On the left the bifurcation was behind the hypoglossal nerve, which was drawn down, and the ligature then passed just below the digastric. The lingual and facial branches were not seen on the right side; but this caused no apprehension, as the facial was said to have been tied some months before, during removal of the diseased submaxillary gland on that side. On the left side the branches of the external carotid were normal. The operations were antiseptic throughout. The malignant growth diminished in size rapidly, the discharge became scanty, thin, and watery, and the ability to speak and swallow improved quickly. On the fifth day a portion of the growth on the right side sloughed out, leaving an aperture bounded by sloughy tissue, at the bottom of which could be seen necrosed bone in the lower jaw. Nine days after the operation profuse hæmorrhage took place, with a fatal result. This hæmorrhage was caused by sloughing of some of the diseased starved tissue, into which the trunk common to the facial and lingual passed.

In the second case no hæmorrhage or sloughing followed on ligature of the external carotids. For two months the state of the patient was much improved, the growth showed but little tendency to increase, and the pain and dysphagia did not return. Then profound cancerous cachexia set in, with emaciation and loss of strength, beyond which there is no note.

Excision of the External Carotid.—This method has been introduced in America to meet the objections which may accompany mere ligature of the artery, viz., secondary hæmorrhage if the wound unavoidably becomes septic, and, in the case of growths, the reactivity which sets in when the collateral circulation is restored. The following account is taken from Dr. Coley's article on "Cancer" (*Twentieth Century Practice of Medicine*, vol. xvii. p. 405): "R. H. M. Dawbarn, of New York, has originated a method of dealing with inoperable malignant tumours in regions deriving their blood-supply from the external carotid arteries, which he designates as 'excision of the external carotid arteries.' Attempts to starve malignant tumours by cutting off the arterial supply had previously been made, but never systematically. Four years ago, J. D. Bryant, of New York, reported before the New York Medical Society a case of inoperable naso-pharyngeal sarcoma which apparently disappeared after ligature of both external carotid arteries, the patient remaining well nearly ten years afterwards. Bryant tried the method on a number of other similar cases, but the results were always confined to temporary shrinkage of the tumour. Dawbarn, reasoning from these results that the first case was successful because there happened to be present poor anastomotic connections, and that the other cases were improved at first, but later became worse as soon as anastomosis developed, conceived the idea of *excising* the carotids."

"The *technique* of the operation is as follows :—Ligate the external carotid just above its origin. Cut just above, and seize the upper cut end with stout artery-forceps. These hold the vessel as a handle throughout. Working upwards, tie off between two ligatures and divide each branch as reached. When the artery at length disappears into the substance of the parotid gland, use gentle traction on the artery downwards while *stretching* with a dressing-forceps a passage up into the gland. Avoid the knife here, to threaten facial paralysis as little as may be. At length one is able to slip a single ligature about the two terminal branches just above their origin—the internal maxillary and temporal—and to divide the end of the external carotid."

Dr. Dawbarn has recently modified his *technique* (*Intern. Clinics*, 1905, vol. i. p. 112). After the different branches of the external carotid have been found and tied, they are cut, and the distal portions injected with a mixture of white paraffin and gelatin, introduced at a temperature of about 120° F. The two trunks are dealt with at an interval of about fourteen days. The result of his experience is as follows :—"For sarcomas the result is particularly favourable. Cases are now on record in which three, four, five, six, and even seven years after the tying of the external carotid, there has been no recurrence of sarcomatous tumours which were growing rapidly before the operation, but which dwindled immediately afterwards, and have never again resumed their malignant activity. In one very severe case of sarcoma of the base of the skull, in which the tumour was very large and had yielded somewhat to the injection of Coley's toxin, but had afterwards resumed its growth, the tying of the external carotids led to the gradual disappearance of the tumour; and it has not recurred. Unfortunately this is not so true for the carcinomas. Improvement follows the cutting off of the blood-supply to malignant growths of this kind, but the relief is not permanent. In a few instances there was marked diminution in the size of the tumour, followed by the relief of symptoms for from a few months to a year. Recurrence, however, has inevitably taken place in all true carcinomas, though usually the patient has suffered very much less before the fatal termination than would have been the case had the carotid not been tied. In every instance the tumour has shrivelled, and great temporary benefit has been derived from the operation."

v. Hæmorrhage from Middle Meningeal Artery after Trephining.—This matter has been considered at p. 265, and more fully in *Guy's Hosp. Rep.*, vol. xliii., where it is shown that severe hæmorrhage is not uncommon after a wounded middle meningeal has been exposed by trephining, but that the bleeding will usually yield to measures short of ligature of the external carotid.

GUIDE.—The anterior border of the sterno-mastoid above the hyoid bone.

RELATIONS.—The external carotid extends from the upper border of the thyroid cartilage to a point midway between the external auditory meatus and the condyle of the jaw; beyond this point it is continued on as the temporal, having just before given off the internal maxillary. In the first part of its course the external is somewhat nearer the middle line than the internal carotid, and is more superficial than this throughout.

IN FRONT.

Skin; fasciæ; platysma; nerves from transverse cervical and facial; superficial veins.
 Lingual and facial veins.
 Digastric and stylo-hyoid.
 Parotid; facial nerve; temporo-maxillary and other veins.

INSIDE.

Pharynx.
 Hyoid bone.
 Ramus of jaw.
 Parotid.

OUTSIDE.

Parotid.
 Temporo-maxillary vein when this descends to join the internal jugular.

External carotid.

BEHIND.

Parotid gland.
 Superior laryngeal.
 Glosso-pharyngeal.
 Stylo-glossus and stylo-pharyngeus.

The veins in relation with the external carotid vary a good deal. But, in addition to the lingual and facial crossing it, a number of veins joining the external and anterior to the internal jugular may form a kind of plexus round the artery, and the temporo-maxillary may descend outside the artery to join the internal instead of the external jugular.

BRANCHES* :

ANTERIOR.	POSTERIOR.	ASCENDING.	TERMINAL.
Superior thyroid.	Auricular.	Ascending pharyngeal.	Temporal.
Lingual.	Occipital.		Internal maxillary.
Facial.			

Operation.—This is performed at two spots :

a. Below the digastric (Fig. 271).

b. Above this muscle, behind the ramus of the jaw.

a. **Below the Digastric.**—This is the operation more frequently performed in order to cut off the blood-supply through all the branches of the artery. Though these are so numerous, and vary somewhat, there is usually a spot, from one-half to three-quarters of an inch, between the superior thyroid and the lingual on which a ligature may be safely placed, especially if the superior thyroid and linguals be ligatured as well.

To meet the difficulties which may be met with, and to expose the

* While this is a common arrangement, it is by no means the only one. Very frequently one trunk gives off two or three arteries. Sometimes all the branches, save the two terminal, arise very close together, the external carotid constituting then an arterial axis. It is the presence of these branches which enables the surgeon to decide whether he is dealing with the external or internal carotid.

DR. H. L. PARISH

OFFICE AND RESIDENCE, WASHINGTON ST., CALISTOGA, CAL.

R For _____

Rubber bandage
Pins

Date _____ No. _____

L CAROTID.

775

common trunk must first be traced upwards.

of the surgeon being the incision is made, in the line of the upper border of the thyroid gland, divide skin, fasciæ, and muscle, the cellular tissue in the incision of the common trunk or the hypoglossal artery, this the sterno-mastoid muscle, -e.g., facial or lingual—incised with double chromic acid, the nerve being defined, exposed, and the vessel carefully ligated. The use of the steel needle on the outer side of the artery, internal carotid. At the same time the nerve running obliquely downwards and laterally behind the vessel should be ligated. The needle should be introduced from the facial, and lingual should be introduced from the pharyngeal if it can be reached.

Wound of the Jaw.—This entails the division of

and supported, the surgeon divides the ear, just behind the ear. The sterno-mastoid muscle and stylo-hyoid down to the jaw, divide these latter muscles, the latter enters the parotid gland, and the former divides the parotid gland.

The incision may be passed from either side, as is most convenient to the surgeon.

Several veins communicating between the facial and the external jugular will probably cross the line of incision, and must be dealt with.

LIGATURE OF THE INTERNAL CAROTID.

Indications.—These are extremely few.

1. Wounds, usually Stabs.—The following striking case is quoted by Dr. Lidell (*Intern. Encycl. of Surg.*, vol. iii. p. 111; *Amer. Journ. Med. Sci.*, Jan., 1879, pp. 142, 143), and reflects the greatest credit on the medical men concerned:

On July 31, 1869, a man was wounded in the neck, at the angle of the lower jaw, by a knife, which penetrated several inches, opening the internal carotid. Alarmed by the tremendous outjets of arterial blood, Dr. Denning, in whose drug-store the stabbing occurred, at once compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it. Hæmorrhage

desired vessel quickly, the bifurcation of the common trunk must first be found, and the artery which gives off branches traced upwards.

The position of the patient's head and that of the surgeon being the same as at p. 759, an incision three inches long is made, in the line of the artery, from the angle of the jaw to the upper border of the thyroid cartilage, about a quarter of an inch in front of the anterior border of the sterno-mastoid. This incision should divide skin, fasciæ, and platysma; any superficial veins being secured, the cellular tissue in front of the muscle is opened up, and the bifurcation of the common carotid and the posterior belly of the digastric or the hypoglossal identified as guides to the vessel. In doing this the sterno-mastoid should be drawn outwards, any large veins—*e.g.*, facial or lingual—pulled aside with a strabismus-hook or secured with double chromic gut ligatures before division. The muscle or the nerve being defined, the pulsation of the artery is felt for below them, and the vessel carefully cleaned just above the thyroid cartilage. The use of the steel director or knife should be most cautious on the outer side of the artery, where lie, below, the internal jugular and the internal carotid. At the same time the presence of the descendens cervicis on the artery is to be remembered, and that of the superior laryngeal nerve running obliquely downwards and inwards behind the vessel. The needle should be passed from without. The superior thyroid, facial, and lingual should be ligatured at the same time, and the ascending pharyngeal if it can be found.

b. Above the Digastric, behind the Ramus of the Jaw.—This operation has the disadvantage of probably entailing the division of important branches of the facial nerve.

The head and shoulders being duly raised and supported, the surgeon makes an incision downwards from the tragus of the ear, just behind the ramus of the jaw, dividing the skin and fasciæ. The sterno-mastoid must now be drawn outwards, and the digastric and stylo-hyoid downwards, and it will probably be needful to divide these latter muscles partially in order to secure the artery before it enters the parotid gland, this structure being drawn upwards and forwards.

The needle may be passed from either side, as is most convenient to the surgeon.

Several veins communicating between the facial and the external jugular will probably cross the line of incision, and must be dealt with.

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Indications.—These are extremely few.

i. Wounds, usually Stabs.—The following striking case is quoted by Dr. Lidell (*Intern. Encycl. of Surg.*, vol. iii. p. 111; *Amer. Journ. Med. Sci.*, Jan., 1879, pp. 142, 143), and reflects the greatest credit on the medical men concerned:

On July 31, 1869, a man was wounded in the neck, at the angle of the lower jaw, by a knife, which penetrated several inches, opening the internal carotid. Alarmed by the tremendous outjets of arterial blood, Dr. Denning, in whose drug-store the stabbing occurred, at once compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it. Hæmorrhage

now occurring from the upper end, was arrested by a ligature on the distal side of the wound. The patient was pulseless, and death was considered imminent, but, under energetic stimulation with whisky and ammonia, the circulation was soon restored, and the patient made a good recovery, being in active work nine years later.

2. Aneurysm.*—In the non-traumatic and sacculated variety, which is extremely rare, the decision as to treatment, if pressure have failed, must lie between the Hunterian operation of ligaturing the common carotid or, if the artery be sound, and if there be room above as well as below the aneurysm, of placing ligatures above and below the sac, and opening this to turn out the clots: But one or both of the above conditions may very likely be absent.

If the aneurysm be traumatic, resulting from a stab or gunshot injury in the neck, or if, in spite of other treatment, it be steadily increasing, the only operation likely to avail is the old one.

The following cases are excellent instances of the difficulties which may be met with in these cases, and how they should be dealt with:

Dr. Prewitt, of St. Louis (*Trans. Amer. Surg. Assoc.*, vol. iv. p. 233), has recorded the following most interesting case of traumatic aneurysm:—A negress, aged 17, was shot with a revolver bullet, which entered the cheek over the malar bone and passed backwards. Profuse hæmorrhage took place at once from the wound of entrance, there being none of exit. This was controlled by pressure. A swelling quickly appeared between the ramus of the jaw and the mastoid process, which three months later was found to project into the pharyngeal cavity, crowding the tonsil over the middle line and resting against the uvula.† Externally the swelling reached from the temporal bone to the hyoid. Expansile pulsation, well-marked bruit, and thrill were present. Sense of taste was lost in the right side of the tongue, which was atrophied, and, when protruded, inclined to the right. Pressure on the common carotid arrested pulsation in the tumour, and caused some decrease in size. There was no perceptible difference in the right and left temporal pulses; the pupils were equal. There was persistent headache, and sometimes roaring in the right ear. Difficulty in swallowing had existed from the first. The general condition was unsatisfactory.

It was decided to tie the common carotid at once, but though the pulsation and thrill in the sac seemed arrested at first, they returned in a few minutes. It was then decided, as a forlorn hope (because the diagnosis had placed the opening of the sac close to the carotid foramen), to extend the incision upwards in front of the tragus to determine the feasibility of laying open the sac and tying the vessel upon the distal side of it.

A cautious dissection‡ at the back and upper part of the sac showed that this filled all the space between the mastoid process behind and the condyle and ramus of the jaw in

* Aneurysm of the internal carotid here refers to the cervical part of the artery. The treatment of orbital aneurysm, which often depends on arterio-venous communication (traumatic or idiopathic) between the internal carotid and the cavernous sinus, has already been considered at p. 753.

† With reference to this tendency of internal carotid aneurysms to project inwards Dr. Prewitt thus quotes from Prof. Agnew (*Surgery*, vol. i. p. 591): "The deep situation of the artery, covered as it is externally by the stylo-hyoid, stylo-pharyngeus, and stylo-glossus muscles, and by dense aponeurotic structures which extend down to the styloid process, prevents any very marked prominence of such a tumour on the surface of the neck, and, as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle, its extension inwards becomes an anatomical necessity. Indeed, in this peculiarity lies the chief difference between aneurysm of the internal carotid and aneurysm situated at the division of the common trunk."

‡ It was suggested by Prof. Agnew, at the discussion on this paper, that the jaw should have been divided and the pieces pulled aside to facilitate further dissection; but Dr. Prewitt found that the jaw and sac were closely adherent, and, even if separation could have been effected, there would have been no artery above that could have been tied.

front, the sac seeming also to blend with the skull or to be closely adherent to it. A little reflection made it apparent that any attempt to deal with the sac after the method of Mr. Syme would in all probability prove disastrous, as it would almost certainly be found that there was no portion of the artery between the carotid foramen and the sac to be tied. The wound was washed out with bichloride solution, drained, and closed. On the evening of the eighth day, there having been pyrexia and free suppuration of the wound in the interval, hæmorrhage took place from the sac. The wound was enlarged, and search made with the finger for the orifice of the artery or the carotid foramen. The search being fruitless, and it seeming certain that laying open of the sac or removal of the finger would be followed by speedily fatal hæmorrhage, the sac was packed with strips of lint rolled in iodoform. Hæmorrhage did not recur, but the patient died exhausted twenty-five days after the first operation.

The necropsy was conducted under great difficulty, but it was thought that it was made out that the opening in the artery was close to the carotid foramen. Death seemed largely due to infective causes—*e.g.*, thrombosis of the inferior petrosal and lateral sinuses.

Dr. Prewitt points out that such an aneurysm might be mistaken for one of the occipital, vertebral, and perhaps of the internal maxillary or one of its branches. The chief diagnostic points are the projection into the pharynx; the evidence of pressure on the vagus and glosso-pharyngeal (p. 776); and the exclusion of the vertebral, by the effects of digital pressure below the sixth cervical vertebra (p. 780). He also shows by several cases that aneurysm of the internal carotid has repeatedly, owing to the interference with speech and swallowing, the pain in the neck, and the difficulty in opening the mouth, been taken for tonsillar abscess, and with fatal results. One of these cases may be quoted here:

A man, aged 28, was shot on September 30, 1879, through the right infra-orbital region. No hæmorrhage. At the end of a week the swelling in the face had entirely subsided, but tumefaction of the right side of the neck remained. On the eighth day the patient was out. On the fifteenth he called at Dr. Lee's office, and complained of inability to speak or swallow, and also of severe pain in the right side of the neck, which he said he could not bend. His appearance was that of a man suffering from severe tonsillitis. With considerable difficulty Dr. Lee succeeded in opening the patient's mouth enough to permit of limited inspection. The tonsils and soft palate were so swollen as to preclude inspection of the pharynx. On the hard palate there was a small firm tumour about the size of a hickory nut. Thinking this might be the ball surrounded by inflammatory products, an exploratory incision was made. On the removal of some clots of blood, there was a gush of arterial blood. In consequence of the struggles of the patient, Dr. Lee was unable to control the hæmorrhage, and death ensued in a few minutes.

In the discussion which followed on Dr. Prewitt's paper the following case of traumatic aneurysm of the internal carotid following a stab in the neck was related by Dr. Briggs, of Nashville:

A man, aged 23, had an expansile tumour in the left parotid region, encroaching on the throat, causing difficulty in swallowing. There was a loud bruit, and pulsation in the swelling was lessened by pressure on the common carotid. A small cicatrix pointed to the receipt of a stab six weeks before.

Acting on the principle that a traumatic aneurysm is simply a wounded artery, and should be treated as such, Dr. Briggs performed the old operation. A knife being pushed into the most prominent part of the swelling, this opening was plugged with a finger, which appeared to find the wound in the artery. The opening being enlarged upwards and downwards, large clots were removed, followed by a gush of arterial blood, which was arrested by stuffing the wound with sponges. The incision being prolonged downwards, the common carotid was tied. On the removal of the sponges, the hæmorrhage was as violent as before, and was only arrested by the pressure of a finger in the sac. While this was kept up, the tissues were scratched through, and a ligature placed above and below the opening. Though the incision measured eight inches, there was scarcely sufficient room. At the bottom of the wound the styloid process could be seen, and just anterior and internal to it the ligatures on the internal carotid. The patient made a good recovery.

It will be seen that the two cases of Dr. Prewitt and Dr. Briggs differ widely. Though both were traumatic, in one there was room to place a distal ligature,* in the other there was not. The fact that, in the latter, hæmorrhage did not recur for the twenty-five days in which the patient lived after plugging the sac, leads one to hope that plugging with aseptic gauze firmly and carefully against the base of the skull might be successful in such another case, if the wound could be kept aseptic, and the dysphagia met by tube-feeding.

3. At p. 754 another indication is given, viz., some cases of traumatic exophthalmos, in which ligature of the internal carotid is to be preferred to that of the common trunk.

LINE AND GUIDE.—These are practically the same as those given for the common carotid. The internal carotid lies at first outside and rather behind the external carotid. Soon after its commencement it becomes too deeply placed to admit of ligature.

RELATIONS IN THE NECK:

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid; stylo-glossus; stylo-pharyngeus.
Glosso-pharyngeal nerve.
Parotid gland.

OUTSIDE.

Internal jugular.
Vagus.

INSIDE.

Pharynx.
Ascending pharyngeal.
Tonsil.

Internal
carotid.

BEHIND.

Rectus capitis anticus major.
Superior laryngeal nerve.

Operation.—This is much the same as that for ligature of the external carotid. The artery can only be tied in its first and more superficial part. It here lies outside and rather behind the external carotid. The bifurcation of the common trunk should first be found, and the internal carotid carefully traced upwards, being identified by the absence of branches.

Thus the incision should be made along the anterior border of the sterno-mastoid, and not just in front of it, the centre of the incision lying about half an inch above the upper border of the thyroid cartilage. The sterno-mastoid being defined, and the cellular tissue opened up in front of it, the same superficial structures will be met with as in the external carotid (p. 775). When the carotids are found, the external should be drawn inwards, and the digastric upwards. The needle should be passed from without inwards, avoiding the internal jugular and the vagus.

* Dr. Briggs, with reference to this case, stated that, though the opening in the internal carotid was very close to the carotid canal—not more than half an inch from it—the operation was not so very difficult. The cases given at p. 752 of the old operation for aneurysm of the common carotid may be here referred to.

LIGATURE OF THE VERTEBRAL ARTERY.

Indications.

(1) Wounds and (2) Traumatic Aneurysms may be considered together. There is liable to be much obscurity as to whether it is the vertebral or some other artery—*e.g.*, inferior thyroid, ascending cervical, common carotid, or, if higher up, the occipital—which is affected; and, when it is decided that it is the vertebral artery, it is by no means easy to carry out satisfactory treatment. The best course is to enlarge the wound, and to decide, with the finger, the relation of the wounded vessel and of the hæmorrhage to the transverse processes of the vertebræ. The direction of the wound and the effect of pressure below and above the level at which the vertebral ceases to be compressible—*i.e.*, above the "carotid tubercle" (*vide infra*)—will also be helpful.

If the wound be low down, there are about two inches of the artery available for ligature, and this should be placed above and below the wound. But if, as is more frequent, the wound is higher up in the neck, it will be almost impossible, even after exposing and clipping away the anterior roots of the transverse processes, to find and secure the artery, and the best course will be to carefully plug the wound, a method successfully employed by Prof. Kocher.*

A man, aged 48, had been stabbed in the neck. Daily hæmorrhages, often profuse, took place for three weeks, in spite of plugs of charpie soaked in perchloride of iron. On admission into the hospital a wound was found about an inch to the left of the spine, at the level of the fifth and sixth cervical vertebræ. Through the wound was seen a swelling, feebly pulsating. On removing coagula and opening up the wound, free arterial hæmorrhage came from a cavity about the size of a small apple, at the bottom of which transverse processes could be felt. The bleeding came from both the central and peripheral ends of the artery, between the transverse processes of apparently the fifth and sixth vertebræ. As a ligature could not be applied, a pea-like bit of charpie, soaked in solution of iron perchloride, was introduced between the transverse processes. The head was kept fixed with a stiff collar. On removal of the plug on the fourth day, partly with a stream of water, partly with forceps, no bleeding followed. The patient was discharged cured in five weeks, having had a slight attack of erysipelas.

Aneurysms of the vertebral are always traumatic. There are about twenty-four† cases on record of aneurysms and wounds of this vessel. The situation varies much. Usually it is high up, near the mastoid process.‡

The difficulty of diagnosis of wounds of the vertebral and other arteries, and their results, has been already alluded to. Mr. Holmes (*Lancet*, July 26, 1873) states that there are eleven cases in which the

* Langenbeck's *Arch. f. Klin. Chir.*, Bd. xii. S. 867. A full abstract of the paper is given in the *Syd. Soc. Bien. Retr.*, 1871—1872, p. 202.

† Barbieri, of Milan, quoted by Kocher (*loc. supra cit.*), has collected sixteen; Pilz (Langenbeck's *Arch. f. Klin. Chir.*, Bd. ix.) has gathered together four. Then there are Kocher's, one by Lücke in the same *Arch.*, Bd. viii. S. 78, and the American case given below.

‡ In nine, according to Kocher, the wound was at or above the second cervical vertebra; in two, "at the upper part of the neck"; in six it was below the second cervical vertebra. In four of the latter it was in the neighbourhood of the external carotid artery and its branches: thus in one the wound was at the angle of the jaw.

carotid has been tied for wound or aneurysm of the vertebral, of course with no advantage. This mistake seems to have arisen from forgetfulness of the fact that, while pressure on the common carotid below the transverse process of the sixth cervical vertebra will check all pulsation in the carotid, the branches of the carotid, and aneurysms situated on them, it will also check pulsation in a vertebral aneurysm. Mr. Holmes points out that the above "carotid tubercle" is higher up than is usually supposed, being situated two or three inches above the clavicle; and he lays down the rule that when a traumatic aneurysm is situated in the course of the vertebral, and its pulsations are commanded, however completely, by pressure on the common carotid low in the neck, it ought not to be treated as being carotid, or as affecting a branch of the carotid, until it is clearly proved that its pulsations are stopped by pressure applied above the level at which the vertebral ceases to be compressible—i.e., above Chassaignac's carotid tubercle. Ligature of the vertebral artery in the first few inches of its course being so very rarely available, compression of the artery low down, with the aid of an anæsthetic, if needful, and with the additional help of direct pressure or cold on the aneurysm above, should be made use of.

Dr. Weir (*New York Archives of Medicine*, 1884) records a case of a man stabbed on the right side of the neck, about three-quarters of an inch below the ear, just in front of the sterno-mastoid. A traumatic aneurysm, believed to be of the vertebral, slowly developed. Digital pressure over the carotid tubercle was made use of, and in three hours the tumour was cured.

If pressure fails, and if a vertebral aneurysm increases in size, the surgeon must decide to face the risks of opening the swelling and efficiently plugging it. The gauze should be carried into the aneurysm, the wound being opened sufficiently freely to allow the surgeon to see what he is about, and the head should afterwards be kept rigidly still.*

(3) The vertebral has been tied on several occasions in ligature of the innominate artery, either at the same time, to prevent secondary hæmorrhage, or later on, to arrest this when it has occurred at the seat of ligature owing to the reflux of blood from the subclavian (p. 808). More than once the vertebral has been wounded during ligature of the first part of the subclavian.

(4) Epilepsy.—Dr. Alexander, of Liverpool, has performed this operation in thirty-six cases, after the first case usually tying both arteries simultaneously. The following (*Dict. of Surg.*, vol. ii. p. 786) is his opinion of the value of the operation:

The operation was performed in the hope that a diminution of blood to the hinder brain and the spinal cord would result in a lessening or cessation of the epileptic convulsions, it being expected that the diminution would be more permanent to the parts supplied after ligature of the vertebrae than after ligature of other vessels, on account of the absence of anastomosing branches, and the restraints to dilatation of the unligatured vessels by the long canals through which the vessels pass. For a time these expectations were realised, but relapses soon occurred, and in May, 1884, an analysis of thirty-six cases

* In one case related by Kocher the nerves lying behind the artery were injured, and in another dangerous inflammation of the spinal meninges took place.

showed only eight which had had so few fits since operation that they might be practically considered cured. On account of the uncertainty as to what cases would derive benefit from the operation, Dr. Alexander had ceased to recommend or perform the operation. As far as he could then see, this chapter of surgery might be closed.

RELATIONS.—The vertebral artery, the largest and usually the first branch of the subclavian, arises from the upper and back part of the artery, and ascends at first a little outwards and backwards to reach the foramen in the transverse process of the sixth (sometimes the fifth or the seventh) cervical vertebra. Traversing these foramina, it passes through that of the axis; it then bends outwards and upwards to reach that of the atlas, and, passing backwards, lies in a deep groove on the posterior arch of the atlas behind the articular process, beneath the sub-occipital nerve. In this position it lies in the sub-occipital triangle. Finally, it pierces the posterior occipito-atloid ligament and dura mater, and, running upwards and forwards through the foramen magnum, winds round to the front of the medulla to join its fellow and form the basilar at the lower border of the pons Varolii.

BEHIND.

Cervical nerves (in vertebral canal).
Sympathetic plexus.

OUTSIDE.

Scalenus anticus and phrenic nerve.
Vertebral artery.

INSIDE.

Longus colli.

IN FRONT.

Internal jugular.
Inferior thyroid.
Thoracic duct (left side) crossing from within outwards.
Vertebral vein (often plexiform).
Sympathetic plexus.

Operation.—The head having been suitably raised and turned slightly over to the opposite side, an incision, three inches long, is made along the outer border of the sterno-mastoid, extending to the clavicle. In deepening this incision the external jugular must be looked out for, running parallel here with the outer border of the muscle. When the deep fascia is divided, the sterno-mastoid, together with the vein, is to be drawn inwards, the incision being prolonged along the clavicle, and some of the clavicular fibres detached from the bone if needful. The surgeon then, working with the narrow point of a steel director, carefully opens up the deep connective tissue, and endeavours to define the interval between the scalenus anticus and the longus colli muscles. As the outer border of the former muscle corresponds with that of the sterno-mastoid, this muscle must be well retracted inwards. In defining the vertebral artery as it lies between the scalenus and longus colli the presence of the phrenic nerve lying on the scalene, the pleura internally, the internal jugular, inferior thyroid, and the vertebral veins over the vessel, with the thoracic duct crossing it, on the left side, from within outwards, must all be borne in mind, these structures

being drawn to either side, as is convenient, with strabismus-hooks. The depth of the wound and venous hæmorrhage are difficulties at this stage. The needle is then passed from without inwards. Owing to the deep position of the artery, a good light is essential, and the head must be manipulated so as to relax the deep parts as required. The anterior transverse tubercle on the sixth cervical vertebra is a good guide in cases of difficulty; below it, the pulsation of the artery should be felt. In cleaning the artery previous to passing the ligature the fibres of the sympathetic must be disturbed as little as possible. Temporary paralysis from the interference with these fibres is almost certain, and immediate contraction of the corresponding pupil is of very frequent occurrence, and may be regarded as a pretty certain indication that the vessel has been secured. If the vertebral vein is wounded and cannot be secured separately, ligatures should be placed on artery and vein together, above and below the wound in the latter.

LIGATURE OF THE SUBCLAVIAN IN ITS SECOND AND THIRD PARTS (Fig. 272).

LINE.—From the curved and short course of this vessel no definite line can be given.

GUIDE.—The chief point to remember is the outer margin of the sterno-mastoid, as this corresponds to the outer border of the scalenus anticus, which has to be defined and then traced down to the tubercle on the first rib, the part of the artery to be tied lying on the upper surface of this bone, outside and behind the muscle and tubercle.

RELATIONS (third part):

IN FRONT.

Skin; fasciæ; platysma; branches of cervical plexus.
Venous plexus—viz., external jugular; supra-scapular; posterior scapular; transverse cervical; branch from cephalic.
Transverse cervical and supra-scapular arteries.
Cellular tissue and fat.
Nerve to subclavius.
Subclavian vein (below).

ABOVE.

Omo-hyoid.
Cords of brachial plexus.

Subclavian
(third part).

BEHIND.

First rib.

RELATIONS (second part):

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid.
Scalenus anticus.
Phrenic nerve.

ABOVE.

Cords of brachial plexus.

Subclavian artery
(second part).

BELOW.

Pleura.

BEHIND.

Scalenus medius.

Collateral Circulation.

When a Ligature is applied to the Third or Second Part.—Three main sets of vessels* are here employed, viz.:

ABOVE.		BELOW.
The supra-scapular, The posterior scapular,	with	The acromio-thoracic, the infra-scapular, sub-scapu- lar, and dorsalis scapulæ.
The superior intercostal, The aortic intercostals, The internal mammary,	with	The long thoracic and the scapular arteries.
Numerous plexiform ves- sels passing through the axilla from branches of the subclavian,	with	Branches of the axillary.

When a Ligature is applied to the First Part.—The collateral circulation may be carried on by the superior anastomosing with the inferior thyroid, one vertebral with its fellow, the internal mammary and superior intercostal with the long thoracic and the scapular arteries, and the princeps cervicis with the profunda cervicis (Smith and Walsham, p. 38).

Indications.

i. In some cases of axillary aneurysm—*i.e.*, those in which, owing to the pain, the irritability of the patient, the depth of the artery, or the rapid increase of the aneurysm, pressure is not available. The high mortality met with in past days is due chiefly to three causes, viz.: (1) inflammatory changes within the chest; (2) suppuration of the sac; (3) hæmorrhage (Sir J. E. Erichsen, *Surgery*, vol. ii. p. 212).

ii. Cases of subclavian and subclavio-axillary aneurysm not amenable to other treatment; or where the aneurysm, especially if subclavio-axillary, is small in size (not larger than a hen's egg), with a history of a few months' duration, and distinctly traumatic in origin.

Mr. Poland (*Guy's Hosp. Rep.*, 1871), in his report on subclavian aneurysm, gives nine cases of recovery and twelve cases ending fatally after ligature of the second or third portions of the subclavian for subclavian or subclavio-axillary aneurysm. With regard to the nine successful cases Mr. Poland raises a very important question: Was the aneurysm developed in a healthy artery? If so the success is explained. In three the aneurysm was entirely local, independent of general arterial disease; in two this was doubtful; in four the origin was spontaneous. Whether general atheroma existed here must remain uncertain, as the patients recovered, and the artery, where tied, was healthy. "We can only say this: that subclavian aneurysm in its early stage, occurring in persons of the early or middle period of life, without any indication of disease of the heart or large vessels, may and does recover, and that a cure may be effected by means of a ligature of the third or second portion of the artery notwithstanding the disease is one of spontaneous origin, and therefore presumed to be indicative of arterial disease."

In these successful cases the size of the aneurysm in no instance exceeded that of a hen's egg, and the duration of the cases was short, being under four and a half months.

Of the twelve unsuccessful cases of subclavio-axillary aneurysm there was good reason to believe that in ten at least an atheromatous condition of the arteries existed. The size of the aneurysm was, in all save one, larger than in the first group.

* From Mr. Key's paper, *Guy's Hosp. Rep.*, 1836, on a case in which the subclavian artery had been tied for axillary aneurysm twelve years previously.

Dr. Taylor, of Dublin, has related (*Ann. Surg.*, Nov., 1903) a very instructive case of traumatic aneurysm of the left subclavian, due to fracture of the clavicle, most successfully treated under circumstances of great difficulty.

The man, æt. 62, had fractured his clavicle in the usual way, and tried to work the day after. There was much swelling from the first, and the *x*-rays showed a spicule of bone passing down towards the vessel. Two weeks after the injury a large swelling, with all the evidence of an aneurysm, was present. A fortnight later, an attempt was made to tie the first part of the subclavian after removal of the inner third of the clavicle. Owing to the difficulties met with which led to injury of the vertebral artery, it was determined to remove the centre of the clavicle, expose and control the artery, empty the sac, and apply double ligatures. The subclavian being controlled by pressure and the sac emptied, an opening was found in it of the size of a knitting-needle. Forceps were now placed on the proximal and distal sides of the sac, and allowed to remain on for twelve days, a plug of gauze being introduced between them. The wound granulated satisfactorily, and the patient made a good recovery, though the return of power in the limb was very slow.

iii. As a distal operation, together with ligature of the common carotid for some cases of aneurysm of the innominate and aorta. (See p. 812.)

iv. Preparatory to such operations as interscapulo-thoracic amputation (p. 222).

v. For wounds of the subclavian itself—*e.g.*, stabs. This is very rarely called for.

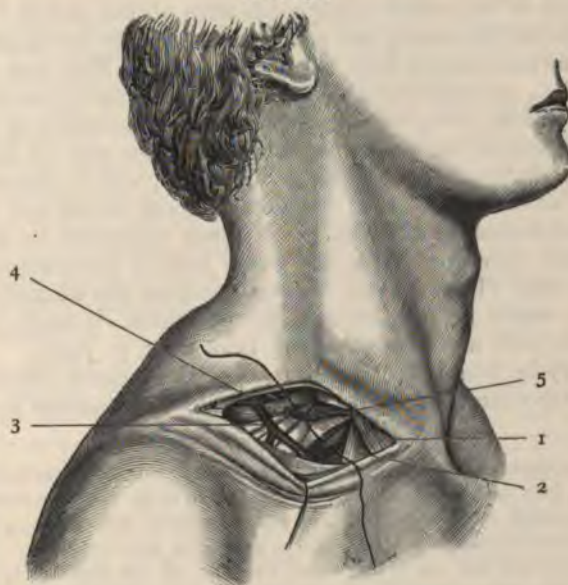
Operation for Ligature of the Third or Second Portion of the Subclavian (Fig. 272).—These two will be considered together, as one operation is but an extension of the other.

The patient having been turned over on to the sound side, propped up with pillows at the edge of the table, the head drawn over to the opposite side, the shoulder on the side of the aneurysm is depressed as strongly as possible, so as to open out the posterior triangle. The surgeon then, standing in front of the shoulder, draws the skin down over the clavicle with his left hand, and makes an incision, three inches long, over this bone, between the sterno-mastoid and trapezius, dividing skin, fasciæ, and platysma. The soft parts being now allowed to glide up, the incision should lie half an inch above the clavicle, the external jugular vein thus escaping injury; for, as this vein perforates the deep fascia just above the clavicle, it cannot be drawn down with the skin, superficial fascia, and platysma. If more room be required owing to the elevation of the clavicle or the presence of an aneurysm, the above muscles must be divided, and a longitudinal incision made upwards, at right angles to the inner end of the first, and a triangular flap raised outwards and upwards.

When the superficial parts have been sufficiently incised, the deep fascia is carefully opened at the inner end of the incision and laid open on a director, and the areolar tissue beneath, which varies much in density and in the amount of fat it contains, scratched through in a direction aiming for the outer edge of the scalenus anticus, which corresponds to the outer margin of the clavicular part of the sterno-mastoid. As soon as the deep fascia is divided, the presence of the following complications must be remembered and provided for. The soft tissues may be much matted, œdematous, and altered owing to previous use of pressure, or inflammation set up around a rapidly

growing aneurysm. The venous plexus formed by the external jugular receiving the supra-scapular and transverse cervical veins, and, often, the posterior scapular and a branch over the clavicle from the cephalic as well, may be much engorged. Any one or more of these veins which are in the way should be drawn aside with a strabismus-hook or aneurysm-needle, or divided between fine catgut ligatures. It cannot be insisted upon too strongly that a bloodless wound will best enable the surgeon to reach this often most difficult artery, and a bloodless wound is best secured by tying beforehand every vein which cannot be drawn out of the way, and by using a fine-pointed steel director as much as possible after the deep fascia is opened.

FIG. 272.



Parts concerned in ligature of the third part of the subclavian. 1, Sternomastoid. 2, Scalenus anticus, below which the subclavian artery is seen deeply with a ligature passed below it. 3, External jugular vein joining the venous plexus here met with. 4, Omo-hyoid. 5, Transversalis colli artery.

As a rule, the transverse cervical artery is above the incision, and the supra-scapular below it, under the clavicle, but occasionally one or both of these may be found lying across the field of operation, and must then be drawn aside with a strabismus-hook. While the veins may be ligatured without hesitation, the arteries must be preserved intact, that the collateral circulation may not be interfered with (p. 783).

The omo-hyoid varies in position, and may be neglected.

By scratching through the cellular tissue the scalene tubercle on the first rib, immediately above and behind which landmark lies the artery, can be felt. One of the lowest cords of the brachial plexus will now come into view, and is another good guide to the artery.

George A. Wright, of Manchester ("Case of Ligature of Subclavian Artery for Axillary Aneurysm," *Ann. of Surg.*, 1888, p. 362), emphasises the value of the lowest

nerve cord as a guide in preference to the scalenus anticus and the scalene tubercle. In his case the muscle was not a very good guide, as "the tense fascia reaching from its posterior border to the sheath of the artery obscured the line of the muscle," and as the artery rose fairly high in the neck, the tubercle was not of much value either.

This cord must not be mistaken for the artery, a contingency otherwise not unlikely to happen, as the lowest cord is in close contact with the artery and may receive pulsation from it.* A little cleaning will show the fasciculation of the nerve, while the artery is closer to the rib, and is flat, not rounded, when rolled under the finger.† By compressing the artery between the needle passed beneath it and his forefinger, and noting the result of this pressure on the aneurysm and the pulse below, the surgeon will clear up any doubts as to whether he has the artery or no.

The position of the artery being made sure of, the sheath‡ is opened with the point of the knife, the artery cleaned, and the needle passed from above downwards and from behind forwards. This best avoids the worst risk—i.e., of including a nerve cord. The needle should be kept most carefully close to the vessel, and not dipped suddenly or used with any force; otherwise the pleura or subclavian vein may be injured.§

The artery, before the ligature is tightened, will be inspected with some anxiety as to its condition—whether normal in size and structure, or dilated, thickened or thinned.|| If much alteration be found, the surgeon should carefully divide the outer half of the scalenus anticus on a director with blunt-pointed scissors, keeping the wound absolutely dry so as to watch for the phrenic nerve, which, if seen, should be drawn inwards with a strabismus-hook (foot-note, p. 790).

If the artery be found diseased here also, the surgeon should use one of the ligatures described at pp. 796, 800, and endeavour so to adjust

* Mistaking a cord for the artery, or tying the two together, has happened to excellent surgeons. Thus, in a case under the care of Mr. Green, of St. Thomas's Hospital, one of the cords was included in the ligature. The agony produced was extreme; the man did not cry out, but the expression of his face was something most appalling. The ligature was immediately loosed, and the artery alone tied, and all the frightful symptoms disappeared. The man made a good recovery, and was seen many years afterwards perfectly well (Poland, *loc. supra cit.*, p. 83).

† Another difficulty about the pulsation is its variableness. Sometimes it is violent and excited; at others, as in the case of a dilated and diseased artery, or one much handled in the operation, it is almost imperceptible (p. 152).

‡ A process of deep cervical fascia which the vessel brings out from between the scaleni, and one which varies much in density.

§ The surgeon should be provided with needles of different curves and a silver probe with a large eye. As pointed out by Sir W. Fergusson (*Surgery*, p. 607), with his attention to details in operations, the eye of the needle should always be close to the point, that the ligature may be at once seized with forceps as soon as it appears under the vessel, the difficulties at this stage of the operation being not only the surrounding parts of importance, but also the fact that in this case the handle cannot be depressed so freely as in operations on most other arteries, and thus it is difficult to make the point rise above the vessel.

|| In a case of Liston's the vessel was dilated, thick, and soft, "aptly enough compared to the finger of a buckskin glove." The patient, aged 43, died of hæmorrhage on the fourteenth day. In a patient of M. Jobert's (Poland, *loc. supra cit.*, p. 110), "the vessel was found enormously large, equal to the size of an aorta; pulsation being very marked."

the tightening of the ligature as not to divide both the internal and middle coats.

In cases where the wound is a very deep one, care must be taken, while making the second knot, that the first does not slip. The ligature having been tightened and cut short, drainage is provided, if needed, and the wound carefully closed and dressed. The limb is then bandaged with cotton-wool and kept somewhat supported, and the temperature maintained with hot bottles if needful.

The Chief Points in the After-treatment are—(i.) keeping the wound rigidly aseptic, (ii.) arresting hæmorrhage, (iii.) meeting supuration of the sac, (iv.) combating the stiffness and weakness of the limb which sometimes follow on ligature of the main trunk.

(i.) This need not be further alluded to in a work like this, but it cannot be too strongly insisted upon that, if the high mortality (pp. 783, 789) which has hitherto attended this operation is to be reduced, it is mainly to keeping the wound aseptic throughout, and thus to early primary union, that we must look.

(ii.) The risk of hæmorrhage is so great that the surgeon should always endeavour to prevent it by trying to obtain early and firm closure of the wound, as just indicated, and by keeping the patient absolutely quiet till all is soundly healed. When once hæmorrhage occurs, the outlook is very grave. The treatment must vary according to the size of the wound which remains. If there be only a sinus, firm pressure must be made over the dressings by well-adjusted bandaging, aided by a heavy bag of shot,* and most absolute quiet.

If the wound be larger, and perhaps septic and sloughy, an anæsthetic should be given, and, any clots having been removed, it must be rendered aseptic, and plugged with strips of sterilised gauze, the part placed within the wound having been wrung out of solution of formalin (1 in 500 or 750), or turpentine, and pressure applied as above. The patient should be kept as quiet as possible with morphia; the diet should be restricted and given at regular intervals, and without stimulants unless absolutely required. The cases collected by Mr. Poland (*loc. supra cit.*, pp. 116, 117) show that while hæmorrhage may occur as early as the eighth day, it may be deferred till the twenty-sixth or forty-sixth day, the ligature having come away on the twentieth day in either case. In neither of these two latter cases had the wound healed; in the first, the patient had been allowed to get up; in the second, pyæmia was present.

The above and the following remarks apply chiefly, of course, to the days when ligature of arteries for aneurysm was much more common, before the period of aseptic surgery and the employment of sterile ligatures.

The same writer (*loc. supra cit.*, p. 125) thus sums up the sources of hæmorrhage :

(a) *From the sac*, either *primary* from puncture during the operation, or *secondary* from ulceration or rupture at an early period, or later after inflammation and suppurating and giving way of the sac.

(b) *From the ligatured part*, in consequence of non-obliteration of the artery when the ligature is becoming detached, the hæmorrhage being generally from the peripheral

* In a large hospital where relays of assistants are available, digital pressure may be made use of.

end of the artery tied. It may be due also to an unsound state of the coats of the artery, such as dilated, thinned coats or atheromatous degeneration.

It is worth remembering that this hæmorrhage is, in exceptional cases, recovered from. Mr. Poland (*loc. supra cit.*, p. 127) quotes four cases from the collection of Kocher which recovered after the use of styptics, pressure, and cold, and adds one under the care of Sir W. Fergusson (*Edin. Med. and Surg. Journ.*, 1831, p. 309), in which the hæmorrhage was arrested promptly and for good by pressure applied immediately by the patient's wife.

(iii.) Suppuration of the sac. The frequency of this untoward accident has been already alluded to (p. 783). It is due to the close proximity of the ligature to the sac, without any intervening branch, whereby the necessary coagulum is but ill formed and loose, acting as a foreign body, and liable to set up irritation, inflammation, and its consequences.

Every endeavour should be made to prevent its occurrence by forbidding all handling of the aneurysm.

If evidence of it occur, and the swelling, which has at first diminished in size, again about the second or third week steadily increasing in size, become tense and painful, but without pulsation, it must be opened by a sufficiently free incision, carefully emptied of pus and clots, drained, and well-adjusted pressure applied. If the wound have not healed, and particularly if it is infected, hæmorrhage is extremely likely to occur after opening the sac—an ominous complication, which can only be met by plugging with aseptic gauze and using firm pressure (p. 787).

(iv.) Atrophy, stiffness, and weakness of the limb. These must be met by warmth, use of electricity, and, above all, by perseveringly used massage.

The condition which is so common in the lower extremity after an analogous operation (see Ligature of External Iliac), in which the limb long remains in a state not far removed from gangrene, is much less common in the upper extremity.

Difficulties and Accidents which may be met with, and Points to avoid, during the Operation.

1. Sterno-mastoid and trapezius almost meeting.
2. A short full neck with much fat both above and beneath the deep fascia.
3. Clavicle much pushed up. This may be due to the patient having carried his shoulder raised to relieve the painful pressure on the nerves, or to the presence of an aneurysm.
4. The artery may be displaced.

This deviation from its usual course may be acquired, as in a case of Warren's (Poland, *loc. supra cit.*, p. 77), where the left subclavian was raised and displaced by a curvature of the spine in a woman, aged 30, the subject of an aneurysm (attributed to strain) about the size of a pigeon's egg, just above the scapular end of the clavicle. Ligature was performed by an incision made obliquely from the outer edge of the sterno-mastoid towards the acromio-clavicular joint, the pulsation of the artery being the guide.

Congenital deviations which have been met with are the artery perforating the scalenus anticus, or lying in front of it or, as usual, behind this muscle, but now closely accompanied by its vein.

5. The soft parts infiltrated, œdematous, or matted together owing to the presence and irritation of an aneurysm, aided, perhaps, by previous attempts at cure by pressure.

6. Great engorgement of the veins met with here, due to the presence of an aneurysm, and increased by the anæsthetic.

7. An aneurysmal sac very prominent and liable to be punctured in the operation.

This accident took place in the hands of the elder Travers. The sac was as large as a swan's egg, and pulsated strongly. The patient died on the third day after the operation, with effusion into the right pleura. The ligature was firmly seated on the artery at the root of the sac and adjoining the outer edge of the scalenus. The sac had a pouch-like enlargement upwards, which closely overlaid the artery on the pectoral side; and this, having been penetrated in the passage of the needle, had occasioned the profuse arterial hæmorrhage without saltus, which was not arrested by the tightening of the ligature, and which was only controlled by introducing a sponge tent into the wound. The same accident is stated by Sir J. E. Erichsen to have happened to Cusack while ligaturing the subclavian for a diffused aneurysm of the axillary artery.

The alarming gush of blood which took place was arrested by plugging the wound, but the hæmorrhage recurred fatally on the tenth day.

8. Wound of the supra-scapular artery necessitating ligature of this branch. As a rule this artery lies too low down to be injured—a complication to be extremely deprecated, as it is one of the chief channels by which the collateral circulation is established (p. 783). In about one out of every three cases the posterior scapular will be found to arise from the third part of the subclavian as a separate branch. Erichsen (*Surgery*, vol. ii. p. 208) advised, if this condition were met with, that the ligature should be applied, as far as possible, "to the proximal side of the branch. If necessity obliges the ligature to be applied close to the branch, it is perhaps safer to tie this also, as the anastomosis of vessels in this region is so abundant that the risk of gangrene from the obliteration of a single branch would be very small." But, according to the results of a necropsy in which Mr. Key had tied the artery twelve years previously for axillary aneurysm, both the posterior and the supra-scapular are very important channels by which the blood is carried into the axillary through the infra-scapular (*Guy's Hosp. Rep.*, 1836).

Any artery crossing the subclavian should be, normally, the transverse cervical. This or any other vessel which may be an artery should be drawn aside with a strabismus-hook.

9. Pulsation in the artery weak or deficient, or, on the other hand, excited and tumultuous (p. 786).

10. Including a cord of the brachial plexus (p. 786).

11. Injuring the pleura. This has happened on several occasions during the passage of the needle round the artery, owing to the close proximity of the serous membrane to the vessel, and the difficulty in passing the needle, especially when the clavicle is much raised, rendering it impossible to pass the needle from below, and thus away from the pleura.

Erichsen (*loc. supra cit.*, vol. ii. p. 212) considered inflammation of the contents of the thorax to be the most frequent cause of death, proving fatal in one out of every 2·5 cases. This is not pyæmic, but arises from causes essentially connected either with the operation or with the aneurysm itself. "These are referable to three heads. (1) Septic inflammation of the deep areolar tissue at the root of the neck may

extend to the anterior mediastinum, the pleura, and pericardium. . . .

(2) The sac may, by its pressure inwards, encroach upon, and give rise to inflammation of, that portion of the pleura which corresponds to its posterior aspect. (3) Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the lungs; and although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurysm, yet it undoubtedly has occurred, as I have myself witnessed in one case."

12. Injuring the nerve to the subclavius, or including it in the ligature. This nerve, derived from the junction of the fifth and sixth cervical, usually gives a filament to the phrenic. If, as occasionally happens, this filament is replaced by a nerve constituting an important part of the origin of the phrenic, injury to it will be followed by urgent and speedily fatal dyspnœa.

13. Injury to the subclavian vein. This is rare, as the vein lies below and well away from the artery. But if ligature were called for in a case in which the vein accompanied the artery between the scaleni, this deviation would prove embarrassing.

I have spoken at p. 786 of division of the scalenus anticus if the surgeon does not find the part of the artery beyond this muscle healthy. It is not needful to speak at length and separately of this step, as it is a mere extension of the operation for ligature of the third part, the muscle being also only divided in part. Mr. Poland (*loc. supra cit.*, p. 128) points out that, of eight cases in which the scalenus was partially divided, five recovered, and that of these five recoveries the operation was on the left side. These cases thus fully prove that a ligature may be placed on the second part of the artery without fear of want of thrombus formation or of injury to important parts.*

LIGATURE OF THE FIRST PART OF THE SUBCLAVIAN.†

As this operation has been performed by surgeons of the highest eminence, and as it affords good practice on the dead subject, it will be given here. How far the improvements of modern surgery, aided by recently introduced ligatures and removal of the inner part of the clavicle, will ever render this a successful operation, and meet that secondary hæmorrhage which has proved so fatal from the distal side of the ligature, owing to the facility with which the numerous collaterals bring in blood to this spot, remains to be seen.

* As shown by Mr. Poland, the remarks of Porter on the numerous and great perils of this operation are scarcely borne out—viz., the phrenic on the scalenus anticus; the thoracic duct lying, on the left side, at the inner edge of the muscle; the three large branches usually given off by the subclavian while between the scaleni; and the close proximity of the first dorsal nerve behind the artery.

† These remarks refer chiefly to the right subclavian. A ligature has certainly once been placed on the first part of the vessel on the left side, Dr. Rodgers, of New York, being the operator, and losing his patient from hæmorrhage on the fourteenth day. Sir J. E. Erichsen (*loc. supra cit.*) states that Sir A. Cooper failed in an attempt to secure the vessel, and that he is said to have wounded the thoracic duct. See also Sir W. Mitchell Banks' remarks p. 806. Mr. Stonham's successful case is given at p. 792.

RELATIONS.—These, owing to the greater depth of the artery on the left side, must be given separately.

IN FRONT.

Skin ; fasciæ.
 Sterno-mastoid ; sterno-hyoid ; sterno-thyroid.
 Internal jugular and (often) vertebral vein.
 Vagus ; phrenic ; cardiac nerves.
 Right subclavian (first part).

BEHIND.

Recurrent laryngeal ; sympathetic.
 Longus colli ; pleura (and beneath).

IN FRONT.

Sterno-mastoid ; sterno-hyoid ; sterno-thyroid.
 Pleura ; lung.
 Vagus ; phrenic ; cardiac nerves.
 Internal jugular ; innominate veins.
 Common carotid.

OUTSIDE.

Pleura.

Left subclavian
 (first part).

INSIDE.

Trachea.
 Œsophagus ; thoracic
 duct.

BEHIND.

Sympathetic.
 Œsophagus ; thoracic duct.
 Longus colli.

Operation.—This resembles ligature of the innominate. The following account is taken from Mr. Barwell* :

A triangular flap having been turned upwards and outwards, and both heads of the sterno-mastoid divided, the anterior and, if needful, the external jugular veins are secured with double chromic-gut ligatures, and divided. The fascia over the sterno-hyoid being exposed, "the director, after a little opening in the aponeurosis has been made, can be insinuated behind that muscle, which also must be severed. It is well now to look and feel for the carotid artery before going on to divide the sterno-thyroid, whose outer edge covers that vessel, and never, as far as my experience of the dead subject goes, conceals the subclavian."† The finger of the operator, after division of the sterno-hyoid, readily detects the longitudinal course and pulsation of the carotid, and may with ease push the edge of the sterno-thyroid from off its sheath inward, in which position the muscle should be held with a blunt hook. When the sheath of the vessel is thus brought into view, the operator should look for the large veins that always, but more especially if there have been dyspnoea, overlie it. Choosing a vacant spot, he merely nicks the loose structure in which they lie, and then pushes them up and down, tearing the cellular tissue a little, till the dense fibrous sheath is bared sufficiently first to have a small opening made in it, and then to be slit up. This should be done on the front and inner aspect. Now, at this part the

* *Intern. Encycl. Surg.*, vol. iii. p. 513.

† "The mere division of the muscle is in itself unimportant, but there lies behind it a plexus of large veins, passing from the thyroid body to the internal jugular, generally distended by the dyspnoea accompanying aneurysm at the root of the neck. Their division causes profuse bleeding, and subsequent difficulty in recognising the deeper parts."

vein diverges a little from the artery, so as to leave a triangular interval, through which the vagus runs. A blunt hook is placed over this, and it is to be drawn with the jugular vein gently outward. The next point is to find the subclavian. To do this the operator must remember that the usual description and delineation of the innominate bifurcation is incorrect. It is generally depicted as if the two branches rose side by side and almost at right angles to each other. In reality, the subclavian springs behind the carotid, and the angle between the two vessels is very acute. Therefore, to detect the subclavian, the operator must place his finger at the back and outer part of the carotid, when, passing it down, he comes, generally a few lines above the clavicle, to the slightly divergent pulsating line of the subclavian, which lies deeper than the carotid by the whole diameter of that vessel.

In selecting the spot for placing the ligature, it is well not to put it quite close to the bifurcation, but also not too near the scaleni, lest the recurrent laryngeal or the phrenic should be injured. The vagus and the jugular vein should be kept, not too forcibly, outwards, and the needle should be passed from below, while with his left forefinger the surgeon gently presses the pleura downwards and outwards. Some obstruction behind the artery will very likely be encountered, but it is better gently and patiently to overcome this, and never on any account to attempt to pass the needle the other way; for if this be attempted, the instrument is certain to penetrate the pleura. Having now passed and tied the ligature, the surgeon should consider the advisability of also securing the vertebral. It lies in the groove between the longus colli and scalenus, so that the jugular vein must now be held inwards; the dissection already made will have so nearly exposed the artery that a few touches with a director will lay it sufficiently bare to allow the passage of the needle. The position of the phrenic nerve on the anterior scalene, outside and a good deal in front of the vessel, guards it against much risk of injury, but still it must be carefully avoided. The operator must not mistake the inferior thyroid (which is, however, much smaller, and usually at this part external) for the vertebral* itself.

As Mr. Stonham's case of ligature of the first part of the left subclavian for aneurysm of the first and second parts of this vessel (*Lancet*, Aug. 2, 1902) is one of the few cases in which this operation has been completed and ended successfully, I give the details. They emphasise in the strongest way the need of removing the inner part of the clavicle in these cases (p. 803). The patient being in the usual position, with shoulders raised, "a vertical incision, about 6 inches long, was made parallel to the sternal head of the sterno-mastoid, the centre being over the sterno-clavicular joint. In its lower half the incision was carried right down to the sternum; a second incision was then made along the inner half of the clavicle, the knife being here also carried down to the bone. The inner part of the clavicle, for about $1\frac{1}{2}$ inches isolated subperiosteally while the deeper parts were protected, was removed. The floor of the wound was now seen to consist of a portion of the clavicular periosteum, a layer of the deep cervical fascia, and muscular tissue. By means of two pairs of dissecting-forceps the outer edge of the muscular layer was clearly defined, the muscles being the sterno-hyoid and sterno-thyroid; these were drawn inwards. Further blunt dissection revealed the carotid running vertically upwards along the inner border of the wound, which was now becoming very deep. On the outer side and below was the dome of the pleura, covered by the junction of the subclavian and internal jugular and a short piece of the left innominate vein. These veins were drawn carefully downwards and outwards, when, deeply behind them, about two-thirds of an inch of the subclavian

* "In certain cases the aneurysmal sac overlying the vertebral art inaccessible."

artery was revealed, surrounded by a little loose fat. The thoracic duct was not seen, nor any veins or nerves other than those mentioned." The artery was now tied with little difficulty by means of a ligature of salicylic acid floss silk passed from within outwards by means of an ordinary aneurysm-needle. The ligature was tied with a surgeon's knot, only sufficient force being used to occlude the vessel.

Within two months of this skilfully performed operation the aneurysm was again enlarging and pulsating. By means of an incision similar and a little external to the first, a triangular flap was turned outwards and upwards. "The remains of the clavicular head of the sternomastoid were drawn outwards and the internal jugular vein exposed. Blunt dissection external to the vein exposed the anterior scalenus and phrenic nerve. The jugular vein was drawn inwards, and the muscle outwards. The transverse process of the sixth cervical vertebra was exposed. A vessel of no great size was now defined in the position of the vertebral artery, and was ligatured with silk; the ligature unfortunately broke, dividing the vessel, which was secured with difficulty, and tied at both ends. No other vessel could be found in this situation, though the foramen through the transverse process could be clearly defined. A second vessel, the inferior thyroid artery, was also tied." As ligature of these two vessels did not arrest, though it materially diminished, the pulsation in the sac, a distal ligature was applied to the third part of the axillary just above the sub-scapular branch. Complete arrest of pulsation followed. The aneurysm was eventually completely cured. Mr. Stonham saw his patient nearly three years later, when he continued quite well, and was doing light work as a carpenter.

LIGATURE OF THE INNOMINATE.

There have certainly been over twenty cases, and in only about five have the patients survived.

One of these is the well-known case of Dr. Smyth's, of New Orleans (*Syd. Soc. Bien. Retr.*, 1865-6, p. 346), which occurred before the days of antiseptic surgery. The second, under the care of Sir W. Mitchell Banks, has never been published. I am enabled, through his courtesy, to give this case below (p. 805). A third successful case of ligature of the innominate has been published by Dr. Lewtas, of the Indian Medical Service (*Brit. Med. Journ.*, 1889, vol. ii. p. 312). While this case, most creditable to the operator, shows what skill and coolness can effect in a terrible emergency, and while it proves that a catgut ligature in a healthy innominate will withstand the force of the blood coming *a tergo*, it must be remembered that the subclavian aneurysm here was a traumatic one of only one month's duration, the artery was healthy, and the patient only 20.

A month before his admission a piece of the breech of a bursting gun had lodged above the right clavicle. A swelling, about the size of a fetal head, occupied the lower part of the posterior triangle, hard to the touch and not pulsating. From a partially healed wound brownish blood had been oozing for three days. As the man was anxious for removal of the foreign body, and as the case seemed to be one of deep cervical suppuration, the opening was enlarged sufficiently to admit the little finger, and a fragment of steel, weighing three drachms, removed with dressing-forceps.

This was followed by an alarming rush of blood, so profuse as to render impossible discovery of the bleeding-point. Fortunately the finger detected the opening in the subclavian behind the scalene, and by pressure an assistant thus arrested the hæmorrhage. The man's condition being desperate, it was decided to tie the innominate and carotid. This was done by an incision along the inner border of the sterno-mastoid and notching the sterno-hyoid and sterno-thyroid. The two vessels were secured with catgut ligatures. A drainage-tube was inserted into the extensive cavity of the original wound, some of the coagula which filled this being removed. The patient made a good recovery.

Mr. Coppinger (*Lancet*, 1893, vol. ii. p. 327; *Trans. Royal Acad. Med. Ireland*, vol. xi., 1893, p. 243) briefly mentions a case in which he successfully tied the innominate for a large subclavian aneurysm. A vertical incision was employed, and silk was used for the ligature. The patient was seen at St. Bartholomew's Hospital two and a half years afterwards, and was quite free from any trace of his aneurysm (Sheen).

Another brilliantly successful case, and one most encouraging to the surgeon, was under the care of Mr. C. J. Symonds. It has not yet been published, and I am indebted to my colleague for the following notes of the case :

G. McCann, aged 53, was admitted October, 1894, for a subclavio-axillary aneurysm. The most prominent part of the sac was just below the clavicle. The whole of the supra-clavicular space was filled, and the pulsating swelling extended backwards under the trapezius to the scapula. It was just possible to limit the swelling at the border of the sterno-mastoid. Fearing that the artery would be unhealthy in its second part, it was decided to attempt to ligature the first part of the subclavian, and if this proved difficult or impossible, to secure the innominate. On November 5 a vertical incision was made between the two heads of the sterno-mastoid muscle, and without much trouble the first part of the subclavian was identified. On attempting to pass the needle, a short sharp gush of blood occurred, which stopped on withdrawing the needle. A further dissection of the artery was made, but again, on passing the needle, the hæmorrhage was repeated with greater force. Pressure of the finger stopped it at once, and, though the pressure was removed, the hæmorrhage was not repeated. As apparently some large branch of the thyroid axis was injured, it was decided to ligature the innominate. The sternal head of the sterno-mastoid was, therefore, divided, and an incision made in the median line. Thus, there were two vertical incisions joined by a transverse one along the inner third of the clavicle. The sterno-hyoid and thyroid were divided, and subsequently sutured with catgut. The common carotid was easily reached, and surrounded with a silk ligature. Slight traction was made upon this; the beginning of the subclavian was identified, and then the innominate brought into view. This was secured by a silk ligature and the wound closed. The muscles were sutured with chromic catgut. The ligature was of stout floss silk. After a few days two openings appeared, one over the inner end of the clavicle and one in the first vertical incision. Through both of these several pieces of catgut came away, and one piece of silk. The man made otherwise an uninterrupted recovery, the pain rapidly disappeared, and the aneurysm became quite hard. When seen in June, 1895, the usefulness of the hand and arm was gradually returning; the aneurysmal sac was hard, but still obvious. There was no pulsation in the brachial or radial. Pulsation could be felt in the carotid above the ligature.

Mr. Symonds reported to Mr. Sheen in 1904, "This man died some time ago of a general malady."

Dr. H. L. Burrell published (*Boston Med. and Surg. Journ.*, Aug. 8, 1895) a carefully reported case of ligature of the innominate for a fusiform aneurysm of the right subclavian and innominate. As in this case death occurred from cardiac collapse (the heart being dilated and hypertrophied) three months after the operation, the wound having healed seventeen days after the operation, it must be considered a successful one as far as surgery and the operation go.

"The following points are of much interest:—(1) The inner end of the clavicle, the sterno-clavicular joint, and the right half of the notch of the sternum for about an inch, were removed (p. 803). (2) The fusiform aneurysm of the subclavian and carotid extended on to the innominate itself, sufficient space being left to place a ligature between this fusiform extension and the aorta. Two ligatures of flat-braided silk were used.* The first was placed three-quarters of an inch from the aorta. Both were tied in "square knots." Fully three minutes were taken in tying the first ligature, this being gradually tightened until the circulation was completely cut off. The second ligature was placed, in the same manner, half an inch higher up. As each ligature was tightened the coats were felt to give way. At the necropsy the innominate showed an extreme degree of endarteritis. The artery was occluded by the upper ligature; by the lower one it was severed, consecutive healing along the line of severance having taken place. Continuity of the lumen of the artery had followed here, and the ligature was found within the vessel, probably covered by a thin layer of the intima. While the fusiform aneurysm had shrunk, very little clot had formed at the site of ligature. For this reason Mr. Burrell, in another case of fusiform aneurysm in this situation, would tie the carotid, if possible the subclavian in its first part, and, if practicable, the vertebral.

It is noteworthy that the operation took an hour and a half, and that though the patient, with general arterio-sclerosis and a dilated and enlarged heart, was under the influence of ether all this time, no ill effect followed.

The extreme danger of the operation is due partly to difficulties which may be met with at the time of its performance—difficulties which have driven most skilful surgeons to abandon the operation—but chiefly to the frequency of secondary hæmorrhage.

In an operation which must be performed at such long intervals it will be some time yet before we know how far modern aseptic surgery is able to diminish the above mortality, with the absence or diminution of suppuration, the more rapid healing, the firmer thrombosis, and the improved ligatures. Lord Lister, speaking of antiseptic ligatures in 1869, wrote thus sanguinely: "For my own part, I should now without hesitation undertake ligature of the innominate, believing that it would prove a very safe procedure."

Two other cases have in late years been fully reported—viz., Mr. Thomson's and Mr. Bennet May's. In spite of all the care taken, and the use of modern ligatures, neither of these cases ended successfully. Mr. Thomson's patient died on the forty-second day, of hæmorrhage, which began on the thirtieth day. It was believed that the sinus which resulted from the drainage-tube became septic, and that the pus had ulcerated into the innominate at a point quite unconnected with the ligature, the latter (ox-aorta furnished by Mr. Barwell) having disappeared. Mr. May's patient died of secondary hæmorrhage on the nineteenth day, caused by the large and very hard knot, which had been tied in the ligature used, ulcerating into the vessel (p. 796).

Two more cases are given in detail below: Sir W. M. Banks' case, with death from hæmorrhage on the thirty-seventh day after ligature of the first part of the subclavian, subsequent to ligature of the innominate (p. 805); and my own, fatal on the tenth day from exhaustion brought on by incessant restlessness in an alcoholic patient, with probably some infection of the wound (p. 807).

Two more recent cases, each finally successful after other operations which emphasise the gravity of this condition, must be alluded to. They are recorded by Mr. W. Sheen, of Cardiff (*Ann. of Surg.*,

* Two ligatures are considered necessary, "one to act as a breakwater by obstructing the constantly recurring waves of blood coming from the aorta,"

July, 1905), and Dr. B. F. Curtis (*ibidem*, October, 1901). Mr. Sheen's paper contains full references to other cases.

Mr. Sheen's patient was 46. The aneurysm affected the second and third parts of the right subclavian. The innominate was reached by a five-inch median incision, without removal of bone, and the vessel tied with stout floss silk (No. 2 pearl-silk) passed double round the artery and tied by Ballance and Edmunds's stay-knot. The carotid was also tied. Pulsation returning in the aneurysm, an unsuccessful attempt was made about six weeks later to again tie the innominate. After another interval of a fortnight, the second part of the subclavian was ligatured with No. 4 Chinese twist tied in a surgical knot. The aneurysm consolidated, and the patient was well eight months after the first operation.

In Dr. Curtis's case a free median incision was made, the manubrium sterni divided in the middle line and transversely above the right second rib. The innominate was tied with a double stout chromic gut ligature, the inner coat not being divided; a single similar ligature was placed a quarter of an inch distally to the first. Pulsation returned four days later. About three months later the carotid and first part of the subclavian were tied; the innominate was impervious, the pulsation in the sac being attributed to some branch of the first part of the subclavian. When last seen, eleven months later, the patient was well, and apparently cured of his aneurysm.

Whatever material he employs, the surgeon must have several ligatures reliably sterilised, as their breaking is still an accident to be prepared for.

With regard to **the best material for ligature** in these cases where the artery is perhaps diseased, where the blood will be driven against it with much force, as I pointed out in the last edition of this book, Mr. Symonds's and Mr. Coppinger's successful cases with silk have gone far to help us on this point. Mr. Sheen's case, successful with a silk ligature, corroborates this view, and gives weight to his remarks: "Too much importance has been attached to the question of the best material for ligature, fatal results having been attributed to defects in the ligature when they have really been due to infection at the site of ligature. Silk, as being strong and certainly sterilisable, is the best material. Whether floss-silk or Chinese twist does not matter."

In Mr. May's case the needle—an old-fashioned silver one, flexible, well rounded at the point, and with a large eye—having been passed satisfactorily round the vessel, "was threaded with a small cord to which a strip of ox-aorta material, kindly sent me by Mr. Barwell, was attached, and by it pulled through. In tightening the tape, I had to draw the ends with very considerable force to stop the pulsation, the vessel offering great resistance and pulsating with great force. Just at the critical moment, however, the material gave way and broke across, and a second piece introduced in a similar manner suffered the same fate. I then endeavoured to imitate the principle of the flat ligature by using a cord made up of five or six medium-sized threads of catgut. This bore the strain very well, and, after tightening with sufficient force to completely stop pulsation in the tumour and branches of the carotid, I drew on the ends still further to allow of some subsequent relaxation in fixing the knot. At the same time I endeavoured to avoid crushing the coats of the artery. The ligature was secured with a third knot, and cut short." The patient died of hæmorrhage on the seventeenth day, and it was found that this very precaution, taken with all care and thoughtfulness by Mr. May, had tended to bring about the fatal result. "The ligature still retained a firm hold on the vessel; one or two of the threads were partially absorbed and softened, but others scarcely changed. The knot, unfortunately very large and hard, was quite unaltered. Under the knot, in front of the vessel and in the line of a fold or bend of its wall, was the obvious source of the hæmorrhage, in the form of a ragged hole about the size of a small pea; this opened into the vessel on both sides of the ligature."

While success has been attained by a few operators with different ligatures tied in different ways, when we turn to the results of

experiment we are struck by the diametrically opposite conclusions at which workers have arrived as to the most useful form of ligature and the best means of tying it. This, though at first embarrassing, will be of less importance to those who, like myself, hold that any evidence drawn from ligature of arteries in animals is of little value when applied to those of man. Evidence drawn from ligatures of *healthy* arteries in *healthy* animals must be received with much caution, the difference being very wide indeed between these cases and those where a ligature has to be applied in man for an aneurysm in patients past middle life, and with vessels no longer sound. Anyone who has tied the innominate in man for aneurysm will hesitate to accept conclusions

FIG. 273.



Artery ligated with kangaroo-tendon ($\times 3$), without rupture of its coats, to show the folds into which the wall of the artery is thrown by a kangaroo-tendon ligature when the coats are uninjured. Transverse section made immediately above the ligature; there are three main folds, the middle or largest of which is under the knot.

FIG. 274.



The same artery opened out by a longitudinal incision passing through the knot and the artery wall beneath it. The arrow in the left figure indicates the line through which this incision was made. The knot is seen cut in two, and the folds of the artery wall are exposed, the largest being divided and the halves turned aside. Each fold has secondary folds, indicated by the longitudinal lines on their surface.

(Ballance and Edmunds.)

drawn from ligatures of like material, and tied in like manner, on the carotids of sheep and horses. In addition to the objections already given, the two wounds are totally different. In the case of ligature of the carotid in animals we have a vessel which can be tied in healthy parts, well known for the rapidity with which they heal, and a wound which can be made with very slight disturbance of the soft parts. In the innominate, on the other hand, we have an operation beset with difficulties, often involving, from the presence of an aneurysm, much displacement of parts, and a wound, from its position with its deepest part behind unyielding bone, most difficult to drain efficiently. I have spoken above of the diametrically opposed results at which those who have worked at the experimental side of this question have arrived. This is shown by the papers of Mr. Ballance and Mr. Edmunds, "The Ligation of the Larger Arteries in their Continuity: an Experimental

Inquiry" (*Med.-Chir. Trans.*, 1886, p. 443); "Ligation of the Great Arteries in Continuity, with Observations on the Nature, Progress, and Treatment of Aneurysm" (1891); and Mr. Spencer's "Experiments on Ligation of the Innominate" (*Brit. Med. Journ.*, 1889, vol. ii. p. 73). The first-named writers have arrived at the following conclusions:— (1) That the operation of ligation of a large artery in its continuity should be performed without damage to its wall. (2) That the rupture of the coats of an artery during ligation in continuity is a useless and dangerous proceeding: useless, because the surgeon can secure the effectual occlusion of the vessel by a measure at once safer and less severe; and dangerous, on account of the possible occurrence of hæmorrhage or secondary aneurysm at the seat of ligation, which could not happen if the wall of the vessel were uninjured by the ligation.

FIG. 275.



Floss-silk :
Stay-knot (first stage).

Represents two floss-silk ligatures side by side ($\times 4$). The first half of a reef-knot is tied on each in the same way. The two ends on either side, being treated as one, are drawn upon to occlude the vessel. The hitches lie at the bottom of a deep groove, and are seen to fit into one another.

(Ballance and Edmunds.)

FIG. 276.



Floss-silk :
Stay-knot (completed).

Shows the knot completed by using the two ends on each side as a single cord, and by tying the second hitch as if completing an ordinary reef-knot. The ligatures may also be tied separately.

(3) That, if the artery be diseased, the advantages attending ligation without rupture of the tunics are much magnified. It sometimes happens that the surgeon, on cutting down upon a large artery, observes a state of atheroma so extensive that he is obliged to close the wound and ligate a vessel nearer the heart, and thus expose his patient to considerably increased risk. There is no escape from such a dilemma under the system which declares that the arterial coats must be divided; but with a non-irritating aseptic ligation, so applied as not to lessen the power of the arterial wall, but actually to be a source of additional strength to it, the question of ligation is seen under entirely new auspices, and the occlusion of a diseased artery would be undertaken with an assurance of success almost equal to that which obtains when a healthy vessel is in question. (4) That, when the coats of an artery are uninjured by the ligation, the danger of ligation near a large collateral branch is wholly avoided, because—(a) no danger can accrue from

hæmorrhage when the wall of the vessel is intact; (b) the formation of clot, upon which the safety of the patient so much depends if the wall of the vessel be damaged, has really nothing to do with the adhesive changes which take place in a ligatured vessel; (c) the plastic actions which proceed at the place of ligation are practically alike, whether the tunics be ruptured or not. (5) It would appear that a small round antiseptic ligature which will not become absorbed in less than three weeks, and which during that period holds firmly so as to cause a constriction of the arterial wall, and complete, or almost complete, obstruction of the cavity of the vessel, will so influence the nutrition of the part that permanent occlusion will follow. It is pointed out that by the use of two ligatures a greater length of the intima of opposite sides is brought into contact. (6) That it is no more necessary to use a flat tape-shaped ligature (as revived by Mr. Barwell to prevent damage to the arterial coats during ligation) than to rupture the coats of the vessel. The small round ligature is the most easy to manipulate, and it is not difficult to learn to apply it in the manner here indicated. Mr. Sheen is inclined to take the opposite view with regard to the degree of tightness with which the ligature should be tied. "Injury to the inner coats becomes a dangerous factor only when, in addition to such injury, sepsis is present. Even with a diseased innominate, as Burrell's case shows, the inner coat may be safely ruptured. Further, a study of the cases leads one to the conclusion that if the ligature is drawn tight, dividing, to some extent at all events, the inner coats, there is much less probability of pulsation returning in the aneurysm. In the accounts of older cases (where one's general knowledge of the material and methods employed leads to the conclusion that in each a silk ligature was used drawn quite tightly) no mention is to be found of return of pulsation in the aneurysmal sac, except in one (Lizar's), and there it was quite transitory, and the reports of the necropsies indicate consolidation in the sac. In the later cases, on the contrary, where occlusion without rupture of coats was usually aimed at, return of pulsation has been frequent (Banks, Bennet May, Curtis, Sheen), necessitating secondary operations; and further the return of pulsation has been early, indicating that it has been due to a direct current of blood through the innominate at the site of ligature rather than to the establishment of a collateral circulation." Mr. Sheen places in order of preference the methods suitable for occlusion of the innominate as follows:—(a) Two separate ligatures tied with the especial object of preventing the first hitch slipping, which is probably to a large extent brought about by the force of the blood pumped from the aorta. Two strands are passed beneath the vessel if possible, half an inch or more apart. The first turn of a surgical or reef-knot is then made in the proximal ligature and tightened, pulsation ceasing in the vessel beyond and in the aneurysm. This first turn in the proximal ligature is then held tight, and the force of the pumping blood being thus taken off the part of the vessel encircled by the distal ligature, the latter is completely tied by a surgical or reef-knot. Finally, the second turn is taken in the proximal ligature and fixes it. (b) The "stay-knot." (c) A single ligature tied in a surgical knot. Some amount of damage to the inner coats would be particularly essential in the last method.

Mr. Spencer, from his results of ligature of the innominate in

monkeys, also advises silk, concluding that the best ligature is one of Chinese twist silk which has been kept in 5 per cent. carbolic acid, and boiled in that solution before being used. A silk ligature can be thus "rendered more thoroughly aseptic than any other without injuring its strength, and, being aseptic, it will remain quiet in position without relaxing. The ligature should be tied tight to divide the internal coats."

As long as there is such a wide difference of opinion as to the mode of using the ligature the surgeon should keep an open mind in dealing with an artery like the innominate, according to its soundness or the reverse. In the case of an artery which is diseased, I think the balance of evidence is in favour of a ligature—either tendon or floss-silk, if duly sterilised—tied tight enough to occlude the lumen, but not to injure the internal coats.

The Question of using Drainage.—Personally, had I to tie the innominate again if I succeeded in leaving a dry wound, I should be content to close it after dusting its recesses with sterilised iodoform. If any oozing were going on, I should leave in for forty-eight hours a strip of sterilised iodoform gauze.

The truth is, that these cases of ligature of the innominate in man are too few and far between to give us the only evidence on which we can rely. All results of operations and experiments alike require most careful weighing and checking before they are acted upon.

At the present time, till we have further evidence bearing on the influence of modern surgery on this operation, we may say that in the selection of cases there are some which are clearly most inappropriate, and that there are certain special precautions which should not be neglected during and after the operation.

First, as to **selection of cases**, the following words of Mr. Holmes* should be remembered. The operation "should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-clavicular joint,† or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is more than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it be tied."‡

The following are amongst the **precautions** indicated :

(1) Rigid aseptic precautions persevered with till the wound is soundly closed. (2) Use of a reliable ligature in securing the innominate, probably diseased—viz., one of sterile kangaroo-tail or silk—with care, if possible, that the knot is not a hard one and does not press strongly on the side towards the artery. (3) Securing the carotid artery at the

* *Syst. of Surg.*, vol. iii. p. 112.

† As Mr. Holmes remarks in a footnote, "if the shape of the bones or joints is altered, it is clear that the aneurysm arises in the thorax."

‡ It is, however, very remarkable that in the cases of Porter and Aston Key, though it was found impracticable and undesirable to ligature the artery owing to its diseased and dilated condition, such changes were set up in the vessel by the exposure and manipulation as to lead to gradual cessation of the pulsation in the aneurysm in one case and its diminution in the other.

same time.* By this, in Mr. Spencer's words (*loc. supra cit.*), "a thrombus is then formed in the proximal end of the carotid, which extends to the bifurcation, and thus aids a thrombus in forming in the first part of the subclavian as far as the vertebral; otherwise the blood-flow will pass from the subclavian to the carotid close by the distal side of the ligature of the innominate, and so the operation will lack one of the important characteristics of a Hunterian ligation." (4) Obliterating the cavity and all pockets as thoroughly as possible, after every care has been taken to check all oozing and to leave a dry wound, so as to prevent formation and collection of discharges.

Mr. Thomson, in his exhaustive account of his own case, states his belief that the fatal ulceration into the innominate was brought about by decomposition of discharges collecting at the bottom of the sinus left by the drainage-tube. This decomposition was, he thinks, due to the difficulty of keeping the dressings firmly on a movable part like the neck, to the fact that the skin heals much more quickly than the deeper parts, and that the clavicle assists in preventing the soft parts coming together. He would, in future, use carefully adjusted sponges, and shot-bags over them.

(5) Keeping the patient absolutely at rest till the wound is soundly healed, morphia being used subcutaneously, and any tendency to cough checked at once if possible.

LINE AND GUIDE.—The vessel, one to two inches long, extends along a line drawn from the middle of the junction of the first with the second bones of the sternum to the right sterno-clavicular joint (Holden). Its point of bifurcation varies somewhat.

RELATIONS :

IN FRONT.

Sternum; sterno-hyoid; sterno-thyroid.
Left innominate and right inferior thyroid vein.
Inferior cervical branch of right vagus.

OUTSIDE.

Right innominate vein.
Right vagus.
Pleura.

INSIDE.

Left carotid.

Innominate artery.

BEHIND.

Trachea.

Collateral Circulation.—This is thus given by Sir W. Mac Cormac (*Ligature of Arteries*, p. 75):

CARDIAC SIDE.		DISTAL SIDE.
Trunk.	First aortic intercostal, with	Superior intercostal of subclavian.
	Upper aortic intercostals, with	Thoracic branches of axillary and intercostals of internal mammary.
	Phrenic, with	Musculo-phrenic of internal mammary.
	Deep epigastric, with	Superior epigastric of internal mammary.

* Ligature of the common carotid at the same time as the innominate will not necessarily prevent hæmorrhage, as was shown by Smyth's case, in which the carotid

Free communication of vertebrals and internal carotids of opposite sides inside the skull. Communication of branches of opposite external carotids in the middle line of the face and neck.

Operation.—The patient having been brought into as satisfactory a condition as possible by preparatory treatment, which must include the leaving off for some days all lowering treatment, such as that of Valsalva, the whole area of the operation having been sterilised with scrupulous care, the head, body, and arm are placed as in ligature of the subclavian (p. 784). The surgeon standing in front, makes an incision along the inner half of the clavicle, and another along the anterior border of the sterno-mastoid and upper part of manubrium, meeting the first at an acute angle, each incision being four inches long. The flap thus marked out having been dissected up, the heads of the sterno-mastoid and the sterno-hyoids and sterno-thyroids are divided. This incision was made use of by Mott when he tied the artery in 1818. The fact that it has been employed in successful cases indicates its adoption to begin with, but the surgeon must always be prepared for the need of removing part of the clavicle and manubrium. The above incision has the serious disadvantage of dividing muscles which retract much and leave a large, gaping, deep wound, the difficulty of draining which has already been alluded to. Where the presence of a large aneurysm with one or more processes to its sac increases enormously the difficulties of this operation, and thus calls for free access to the important parts dealt with, I am of opinion that this division of muscles will be found needful. Mr. Spencer, from his experiments on monkeys, advises the use of a single median, vertical incision, made as if for a low tracheotomy, retracting the sterno-mastoid, sterno-hyoid, and sterno-thyroid, opening the sheath and tying the carotid, and then following this down as a guide to the innominate. He argues rightly that if the muscles be retracted only, and not divided, when they are released they will come together, so that no cavity will be left in the deeper parts of the wound. Sound as this reasoning is, I fear there is no comparison between ligature of the innominate in monkeys and the same operation under the conditions which usually call for it in man. Every atom of room will be required, not only on account of the importance of the parts dealt with, the great enlargement of the veins, the presence of a dilated subclavian, a process of the aneurysm extending inwards, or a hugely expanded vertebral as in my case (p. 807), but also because the surgeon may feel bound, as I did, to give his patient the benefit of a less risky operation, and thus be driven to divide the sterno-mastoid in order to examine the fitness for ligature of the second part of the subclavian. I would advise division of the muscles (in a case of any real difficulty), but at a point an inch and a half above the clavicle. If they are divided just above this bone the ends retract behind it, and I found the introduction of sutures impossible. My case also taught me that raising the skin and sterno-mastoid together—a precaution I adopted to secure a heavy flap,

was tied at the same time as the innominate. Hæmorrhage occurred on the fourteenth day, and was repeated at intervals. The vertebral was ligatured on the fifty-fourth day, and recovery ultimately took place. Of five monkeys in which Mr. Spencer tied the innominate, the only one in which the carotid had not been tied died from hæmorrhage.

which will fall better into position, and thus help to close the deep wound—is futile, the contraction of the sterno-mastoid from above raising the skin with it. During these preliminary steps one or two small arteries may be divided and some enlarged veins connected with the inferior thyroids drawn aside or tied with double ligatures; and, in reflecting the above-mentioned flap, the presence of the anterior jugular passing outwards beneath the sterno-mastoid just above the clavicle must be remembered.

The above muscles, when cut, being carefully held out of the way, and a layer of deep cervical fascia varying in strength divided, the pulsation of the carotid is defined, and its sheath opened to the inner side and as low down as possible. Other guides will be found, in the trachea and the subclavian artery, to lead the finger down to the innominate.

The carotid having been traced down, the innominate will be found bifurcating into the carotid and subclavian. It is now that the real difficulties may be met with. (1) Owing to engorgement of the venous circulation, increased by the anæsthetic, the internal jugular and innominate vein may be so much enlarged as to protrude into the wound. (2) An aneurysm may have extended under the artery and flattened it out so as to make it difficult of recognition. (3) The cellular tissue around the vessel and between it and the sternum may be so matted with adhesions as to make it difficult to define the artery and its important relations on the right side—viz., vagus, pleura, and right innominate vein. (4) The artery itself may be greatly diseased and expanded. (5) The bifurcation of the artery may be quite an inch below the joint.

In tracing down the innominate itself, the surgeon must keep his instruments most carefully on the front of the artery. In following the vessel down behind the sternum in order to find a site for his ligature, he will be aided by slightly flexing the head, and if needful by an electric light. The cleaning of the artery must be done with the utmost caution, especially on the outer side, owing to the important structures lying there; of these the innominate vein and the vagus may be drawn outside, but it is only by keeping the director or needle-point very close to the artery here that injury to the pleura can be avoided.

If there be doubt as to the position of the artery, pressure with the finger behind the vessel against the sternum will arrest the pulsation in the carotid and the aneurysm. If the bifurcation of the artery lie, as in my case, a full inch below the joint, attempts should be made, by pulling up the carotid protected by a piece of aseptic gauze, to raise the bifurcation sufficiently for the passing of the ligature. I believe this to be preferable to dragging on the vessel by the ends of a ligature previously tied round the carotid, and left long. If it be impossible thus to raise the bifurcation sufficiently, the inner end of the clavicle must be removed by disarticulating and sawing through the bone; as much of the manubrium, as is needful, is also removed, partly by a vertical and a transverse cut just above the second rib with a saw, partly with a chisel. Dr. Burrell (p. 794) considers this step essential. He quotes Bardenheuer (*Mittheilungen aus dem Kölner Bürger-Hospital*, Estes Heft, 1886) as convinced that ligature of the innominate can

only be intelligently carried out by resection of part of the sternum and sterno-clavicular joint.

Mr. Ballance (*Lancet*, Nov. 1, 1902) split the manubrium, bisecting it vertically with a saw and chisel, and at the level of the upper border of the second costal cartilages added transverse incisions. Pulling apart the two halves did not afford the desired access, so about half an inch of bone was removed on either side of the vertical incision. After this retraction was very effective. Mr. Ballance considers the above method of splitting the sternum (Milton, *Lancet*, March 27, 1897) inadvisable in these cases.

The needle should be passed from without inwards and a little from below upwards to avoid the pleura. In this case, as in that of the subclavian and other deep-seated arteries, the surgeon will do well to provide himself with needles of different curves (of these the late Mr. Durham's needle, in which the curve is twisted laterally at a right angle to the shaft, is a very helpful one), or with a silver probe sufficiently flexible to take any curve, and with a large eye close to the point (p. 786).

The needle should be loaded with thoroughly sterilised silk, or, if preferred, after the needle has been passed, flat ligatures of reliable and sterilised kangaroo-tail should be secured, and then pulled beneath the vessel. The material and mode of securing the ligatures, the latter still an especially moot point, have been alluded to at p. 796. Care should be taken to keep the ligature flat around the artery while tying it, and the knot as little projecting (especially towards the vessel) as possible. In addition to the amount of force used, the surgeon will, by watching the aneurysm—all pulsation in which should have ceased—derive some information as to the extent to which he has constricted the vessel. No doubt severing the vessel between two ligatures would ensure more rest to the parts which have to heal, but the size of the vessel, its probable condition, the doubtfulness as to whether its lumen is completely closed, and the difficulty of placing the ligatures sufficiently far apart forbid the adoption of this step.

The ligatures having been tied and cut short, the common carotid should be tied also, about half an inch above its origin. If the thyroidea ima arise from a point at which it is likely to bring in a reflux current which will dangerously disturb the clot, on which so much depends, this vessel should be tied also.*

The wound is now carefully cleaned and dried, the severed muscles carefully united with chromic-gut buried sutures, hæmorrhage most scrupulously stopped, drainage employed, if needful,† and the wound carefully closed. The limb, previously wrapped in cotton-wool, should be secured to the side and chest, and every attempt made, by elastic bandaging and the aid of a shot-bag, to keep the dressings firmly in place, and thus promote, from the first, steady adjustment of the parts and sound healing. Morphia should be used as freely as is safe,

* This was the case in Lizars' patient (*Lancet*, 1837, vol. ii. pp. 445, 602; Spencer, *loc. supra cit.*).

† If it be possible to suture the cut muscles satisfactorily, and close the deepest part and all pockets of the wound after this has been carefully dried out, drainage may be dispensed with.

to diminish, as far as possible, the sensibility of the patient to the irksomeness of his position. The slightest tendency to cough should be treated at once. The absolute need of rest and quiet should be enforced upon the patient until the wound is soundly healed.

I am enabled, through the courtesy of the late Sir W. M. Banks, to give an abstract of a most interesting case of right subclavian aneurysm in which the innominate and, subsequently, the first part of the subclavian were tied. Owing to the exceeding rareness of recovery after ligature of the innominate, and the survival of a patient for thirty-six days after the placing of a ligature round the first part of the subclavian, it is most instructive.

J. B., aged 50, was admitted into the Liverpool Royal Infirmary February 10, 1883, with well-marked symptoms of aneurysm of the third part of the right subclavian. Attempts to treat the patient by rest, &c., having failed, owing to his obstinately persisting in getting up, the innominate and common carotid were tied, February 26, with the strictest antiseptic precautions. The earlier steps presented nothing remarkable. "Unluckily, the bifurcation was quite half an inch lower than it ought normally to be, and this caused some difficulty in getting the aneurysm-needle round the vessel. I used a needle of the ordinary kind, having a large curve, and threaded with silk. There was about a minute of rather anxious work while the needle was being tickled through the tissues surrounding the vessel, a proceeding which was accomplished solely by feeling as the artery lay too deep for me to see anything that could aid me. By means of the silk thread, a stout kangaroo-tendon ligature was pulled beneath the vessel, then tightened, three knots being placed upon it. I applied the amount of force which I thought would be necessary completely to occlude the artery, but not to damage its coats, and I felt very certain that I had made a thorough and satisfactory ligature of the artery. Whether I really did so or not is a question. . . . The aneurysm ceased to pulsate. I next proceeded to pass a ligature round the common carotid. . . . Being engrossed in this, I took no further notice of the aneurysm. But those who were assisting saw that, after an interval of about two minutes, a certain amount of pulsation returned in the aneurysm. I imagined that this must have arisen from the retrograde circulation along the common carotid and subclavian, and so proceeded at once to tighten the ligature (another kangaroo-tendon) round the former vessel. As soon as this was done the pulsation in the aneurysm again became practically imperceptible." A slight return of pulsation was noticed in the evening of the operation.

The restlessness and irritability of the patient during the first few days were frightful. He tossed about the bed, moved his arm as much as the bandages would allow, loudly demanded stimulants, and swore at everybody about him. He was not, however, in the least feverish or delirious. Practically there was never any suppuration, and the extensive wound healed by primary union. All dressings were discontinued on the thirteenth day, and the patient, who had insisted on getting up on the ninth, went out on the twentieth day with the wound sound.

Unhappily, the pulsation, feebly present in the aneurysm on the evening of the operation, became strong and accompanied with thrill by the third day. Pressure with a bag of shot was tried, but the patient, by his unruly behaviour, did all he could to prevent any consolidation occurring. When the patient went out the aneurysm was quite as soft, and the pulsation and thrill quite as obvious, as before. It very soon decidedly increased, spreading out under cover of the trapezius and pushing inwards the scalenus anticus. "At the end of five weeks it became clear that either the aneurysm must be left alone and the man abandoned to his fate, or that something more must be done. But what? Galvano-puncture and the introduction of wire or other material into the sac have not proved of sufficient utility to entitle them to be considered satisfactory methods of treatment at the present moment, whatever may become of them in the future. Ligature of the first part of the axillary on the distal side of the tumour is not any better. To lay open the aneurysm and attempt to secure the artery on either side

of the aneurysmal opening would almost certainly have been fatal on the spot. To go down through the old cicatrix in search of the innominate, with a view of tying it a second time, seemed very impracticable. Besides, I could not be any more certain of curing the aneurysm the second time than the first. The only thing that remained was to tie the first part of the subclavian. Sixty-seven days after the ligature of the innominate I performed this operation, not using the spray during the dissection, lest it should obscure one's vision, but turning it into the wound after the vessel was tied. By this date the tumour had so increased in size that there was just room on its inner side, and no more, to get at the artery. An incision was made along the hinder margin of the sterno-mastoid, and another extending from it outwards along the clavicle. After getting through the superficial structures, the clavicular portion of the sterno-mastoid was divided, and the internal jugular was followed down to its junction with the subclavian. Here, in consequence of the matting together of parts as a result of the first operation, it became almost impossible to know what one was dealing with, and an unpleasant accident occurred. I tore across a vein of some size close to the point where it entered the angle of junction of the jugular and subclavian. Instantly a rushing and hissing noise showed that some air had got into the venous trunks, and for a brief space the situation was uncomfortable. A finger was put on the aperture, and to our relief the patient showed no signs of being in any way affected by the occurrence. The aneurysm covered by the thin fibres of the scalenus anticus next came into view. My colleague, Mr. Harrison, gently but steadily pushed this outwards with a couple of fingers, and in the very limited space between this and the internal jugular I proceeded to search for the artery, guided by its pulsation. Very slowly, and after an infinity of anxious picking and teasing (for one dared not use a knife), this was exposed about half an inch from the aneurysm. The vessel was obviously thinned and dilated, and this added immensely to the danger of passing the aneurysm-needle beneath it. The needle was threaded with a silk ligature, which drew after it a double catgut ligature. The loop of this being divided, the artery was secured by both portions lying side by side. The knots were drawn very gently, with the intention of merely closing the artery and not of injuring any of its coats. The aneurysm at once became still.

"A very few lines have sufficed to describe this operation, but it took more than an hour to perform, while the difficulty, danger, and anxiety that attended it are almost impossible to describe. Owing to the fact that the parts had already been interfered with, there was a great deal of thickened and cicatricial tissue present. Cutting this was out of the question, as it was impossible to say what was adherent to or mixed up with it. It had, therefore, to be pulled asunder fibre by fibre, with the aid of strong forceps and a dissecting tool. As the operation advanced, the depth at which one had to work became greater and greater, while, in order clearly to make out the various structures, the wound had to be kept absolutely free from blood. Sometimes minutes would be lost in picking up some trifling vessel from which just enough blood would keep welling to obscure the wound. The space in which anything could be done was of the most limited description, and surrounded by dangers on every hand. To the outer side was the bulging aneurysm, to the inner was the internal jugular, below lay the subclavian vein, and immediately beneath the artery itself was the pleura. . . . Compared with this performance, tying the innominate was a mere surgical amusement, and I should never care to repeat it again."

The patient rallied well from the operation, but a few days later developed an attack of broncho-pneumonia, which exhausted him extremely. He slowly rallied from this, but the wound gaped widely. It ultimately healed, save for a sinus, which admitted a probe deeply. On the twenty-third day the patient got up, and by the thirty-first day had been out in the open air. On the evening of this day hæmorrhage occurred from the sinus; frequent recurrences took place, and the patient died on the thirty-seventh day after the operation. By the fourth day the aneurysm had no trace of pulsation, and was small and hard.*

* The notes of this case contain no mention of a necropsy.

The following case of ligature of the innominate which was under my care well illustrates some of the difficulties which may be expected:

A. H. was sent to me by Dr. Lockhart Stephens, of Emsworth, February, 1890, with a large subclavio-axillary aneurysm. The man gave his age as 48; he looked ten years older, and was stout and flabby, with chronic bronchitis and emphysema. Occupying all the lower part of the posterior triangle, and to be felt in the axilla and between the heads of the sterno-mastoid, was a large aneurysm, six inches by four inches. There was no evidence that the innominate itself was involved. Patient had first noticed the swelling a year before, when it was about the size of a walnut. He had been doing his work as a gamekeeper, and shooting rabbits, till two weeks before his admission, February 10. Chloroform having been given, the parts cleansed, and irrigation with lotio hyd. per. 1—2,000 employed throughout, an incision three inches and a half long was made along the anterior margin of the sterno-mastoid, and another transversely outwards, just above the clavicle, over both heads of the sterno-mastoid to a point over the inner part of the aneurysm. The skin and both heads of the sterno-mastoid were divided together, with the hope of keeping the skin down better when the wound was closed, thus better obliterating the large wound and ensuring earlier healing. The sterno-hyoid and sterno-thyroid being divided, two very large inferior thyroid veins secured, and the internal jugular drawn outwards, the inner part of the carotid sheath was opened and this artery traced down to the innominate. The chief difficulty at this stage was due to what was thought to be a pulsating process of the aneurysm, which extended inwards under the jugular and carotid, but was really a hugely dilated vertebral. The carotid being traced down, it was found impossible to pass a ligature below the bifurcation, which lay a full inch lower than the joint. In spite of the aid given me by the late Mr. Davies-Colley, who drew up the carotid, protecting the vessel with a bit of gauze wrung out of carbolic lotion, I was unable to get my finger or a director sufficiently deep behind the clavicle to make sure of being below the bifurcation. I accordingly removed the inner extremity of the clavicle, disarticulating and sawing through the shaft. I was now able, aided by Mr. Davies-Colley's most efficient help, to bring just the top of the bifurcation into view. More than this was impossible, and the aneurysm-needle (one of corkscrew form lent me by Mr. Durham) was passed by touch round the innominate from without inwards. It was previously loaded with silk, to which a piece of ox-aorta ligature, kindly provided by Mr. Barwell, was knotted. In tying the vessel I tried to use force sufficient to close it, but not to injure its coats. Judging from the outside, the walls were well puckered together. Pulsation in the aneurysm ceased at once, and never returned. The carotid was then tied, with a similar ligature, about an inch above its origin, not only to prevent any efflux of blood through it, but also because the vessel was probably weakened by much handling. The wound was thoroughly dried out, and dusted with iodoform, a drainage-tube inserted, and the wound united by twelve salmon-gut sutures. By the third day the aneurysm began to shrink markedly, but the following night the patient began to be restless and delirious, and this increased and persisted. The delirium was peculiar. He was incessantly restless, trying to get out of bed, chattering without ceasing, calling to his dogs, &c. It was most difficult to keep his right arm still, and before long it was needful to secure him with straps. Morphia, sulphonal, chloral, chloral amide, hydriodate of hyoscyamin, were all tried, with very little result. There was also evidence of broncho-pneumonia at both bases. The restlessness and chattering delirium continued, and, in spite of the abundance of food taken, the strength became exhausted, and the patient sank on the tenth day. The wound remained quite sweet throughout. At the necropsy the wound was found to be perfectly sweet, without a trace of pus, and levelling up well. A large sacculated aneurysm occupied the second and third parts of the subclavian and the first and second parts of the axillary. In addition to the main sac, which occupied the posterior triangle, a hemispherical dilatation projected into the upper part of the right pleura. Encircling the innominate, just below the bifurcation, which was on a level with the first costo-sternal articulation, were the remains of a ligature, but no knot could be found, and the ligature was movable with the point of a director. Surrounding the bifurcation of the innominate was a small cavity, from which could be squeezed not more than a drachm, if so much, of quite sweet pus-like fluid. The carotid had

been tied about a quarter of an inch above the top of the sternum, and here, too, the wall of the vessel was very soft, so that in dissecting it a hole was made in the vessel above the ligature. The knot, however, had held well in position. Running behind the carotid sheath, and given off from the subclavian immediately after its origin, was a long fusiform dilatation, which was probably the vertebral much dilated, as large as the forefinger. A small window being cut in the aneurysm showed that this was filled with a greenish-tinted jelly-like coagulum, not blood-stained, and traversed in every direction by isinglass-like threads. The only remnant of a cavity was quite at the back part, where a space into which the tip of the finger could be introduced contained a little fluid blood. The inner aspect of the sawn clavicle was smooth, with granulations save just at its upper part. The pleuræ were absolutely healthy. Both bases were the seat of broncho-pneumonia. It is quite possible that this was infective, as no bacteriological examination was made of the very small amount of fluid in the wound, but if so the degree of infection was slight, as the first three days passed without unfavourable symptoms, and the patient survived till the tenth day. It should be noted that the man had chronic bronchitis before the operation. The mediastinal connective tissue was extensively occupied with air; this had not penetrated beneath the pulmonary pleura, nor produced interstitial emphysema. The aortic and mitral valves, the latter especially, were diseased; the aortic arch was the seat of atheroma, dilated uniformly, irregular on the surface and rough internally, but not calcareous. The abdominal aorta was very bad, full of calcareous plates. The kidneys showed early interstitial nephritis. There was a small hard mass of clot in the innominate, below the ligature, little in the carotid. The brain was normal.

Causes of Death after the Operation.—It may be expected that most of these will, with septic precautions, disappear, viz.:

1. Infective cellulitis and mediastinitis.
2. Lung trouble—*e.g.*, bronchitis, pleuro-pneumonia.
3. Cerebral softening.
4. Pericarditis.

There still remains the terrible complication of secondary hæmorrhage, which has occurred, as yet, in almost every instance, and has always proved fatal, save in Dr. Smyth's case.

Secondary hæmorrhage may occur up to the sixtieth day, as in Graefe's case. It has already been discussed how far modern surgery is likely to prevent this, and certain precautions have been enumerated at p. 796. The treatment, as shown, is mainly preventive. When once bleeding has occurred, little can be done beyond tying the vertebral and common carotid, if this has not already been performed, plugging the wound with iodoform gauze wrung out of carbolic acid lotion or formalin (1—500) or turpentine (p. 745), if nothing else be available, and putting on pressure with shot-bags.

The treatment of recurrent pulsation in the aneurysm by ligature of such vessels as the carotid and subclavian has been illustrated by the cases already given.

SURGICAL INTERFERENCE IN ANEURYSMS OF THE INNOMINATE AND AORTA.

While the distressing nature of these cases justifies a resort to surgery when medicine fails, I would point out—(1) That the surgeon is often called in too late in large thoracic aneurysms, where treatment of any kind is certain to be unsatisfactory. (2) The fact has been too much lost sight of, that large thoracic aneurysms, with their size, varying degree of sacculation, restricted power of collapse, and important surroundings, are on quite a different footing, for operative interference,

from aneurysms of the extremities. Further, the disease here is much less often a local one. (3) That, with regard to the amount of relief which surgery can fairly be expected to give, when the large number of cases, published and unpublished, which have been treated surgically in the last few years are duly weighed, when the difficulties of diagnosis and the risks of operation have been considered, it is clear that permanent cures are extremely few; and that while in some cases decided relief is given, in many published at the time as successes, were the sequel followed up, it would be found that very little real relief had followed, while in not a few, what with the risk of the anæsthetic, the excited circulation, the partial cure of the aneurysm in one direction, and the tendency set up to spread at another spot, possibly less able to bear the strain,* and perhaps with more important surroundings, surgery has not only failed to check but has actually hastened the progress of the aneurysm.

The advisability of resorting to surgical means will be considered under the heads of—A, Diagnosis; B, Treatment, the latter including—(i.) Ligature, (ii.) Introduction of Foreign Bodies, (iii.) Galvano-puncture.

A. Diagnosis between Innominate and Aortic Aneurysms.

—While a precise diagnosis is usually impossible, no pains should be spared in going into all those points which may help in deciding how far the aneurysm is probably limited to the innominate or to the aorta, and, in the case of this vessel, which part of the arch is chiefly encroached upon, for it is only by paying attention to the above points that answers can be given to the two questions which arise—viz., (1) Is any operation justifiable at all? (2) If an operation is justifiable, what is it to be?

Chief Points to pay Attention to in Diagnosis.

1. *The Position of the Aneurysm.*—This is obviously only of value in a few cases, when the patient is seen early, or when he can be relied upon for an intelligent history of his case. Mr. Wardrop's rule was, that innominate aneurysm first presents itself to the inner side of the right sterno-mastoid, carotid aneurysm in the interval between the two heads, and a subclavian one to the outer side of the muscle. Mr. Barwell (*Intern. Encycl. Surg.*, vol. iii. p. 507) writes of the first of the above thus:—"The tumour of an innominate aneurysm generally occupies the episternal notch, but chiefly on the right side, and, even though it may not rise high, takes up the whole breadth of this space. On gently pressing the finger backward and downward, the rounded margin of the sac can be felt. After a little time the sternal end of the clavicle protrudes abnormally, and partakes in the pulsation (communicated), while the sternal and, afterwards, the clavicular portions of the sterno-mastoid are also pushed forward. Not unfrequently the first costal cartilage, outside where it joins the sternum, is also abnormally prominent, and throbs with the beat of the tumour."

* The rapid extension of the aneurysm in another direction after its original growth has been checked by operative interference is well shown by a case of Dr. Churton's (*Clin. Soc. Trans.*, vol. xix. p. 261), in which, subsequently to galvano-puncture, the blood pressure found out other weak spots in addition to the original aneurysm, thus bringing about other saccular projections and fatal rupture into a bronchus.

Mr. Heath thus described (*Dict. of Surg.*, vol. i. p. 81) the possible points of appearance of an aortic aneurysm: "If on the ascending portion of the arch, the sac presses against the sternum, producing gradual absorption of the wall of the chest, and communicating a marked impulse to the right side of the sternum as high as the sterno-clavicular joint, which may be invaded by the tumour in the later stages. If on the transverse portion of the arch, the sac encounters but little resistance in an upward direction, and hence is apt to invade the inter-clavicular notch, to compress the trachea and occasionally the œsophagus, and to produce marked spasm of the larynx by interference with the left recurrent laryngeal. When a sac of this kind rises into the neck, it is a matter of uncertainty to which side it should be allotted, since a tumour projecting most to the right by no means necessarily *originates* on the right side, and *vice versa*."

2. *The Pulse*.—If a decided diminution be found in the right radial and carotid, the aneurysm is probably of the innominate; but an aortic aneurysm near the root of the innominate will bring about the same result.

3. *Pressure Symptoms*.—These will vary with the position as well as the size of each form of aneurysm. Thus, in innominate aneurysm pressure symptoms will vary according as the sac is high up or low down, and pressing inwards or outwards. As to œdema, the value of this must remain undecided while surgeons hold such opposite views.

Thus Mr. Heath (*loc. supra cit.*) and Sir J. E. Erichsen (*Surgery*, vol. ii. p. 75) spoke of œdema of the right side of the neck and upper limb as first noticed. Mr. Barwell (*loc. supra cit.*), on the other hand, speaking more particularly of the low form of innominate aneurysm (usually combined with aortic disease), writes: "The point to be especially remarked is this: the pulsation, dulness, abnormally loud heart sound, &c., are on and to the *right* of the middle line; the venous congestions are on the *left* side of the body, nor does the right participate till late in the disease. . . . When the right side is also involved the aneurysm will have become large."

I cannot find that the other pressure symptoms—viz., laryngeal or tracheal dyspnœa and irregularity of the pupil—are really distinctive between innominate and aortic aneurysm.

Mr. Barwell considers that the following combinations of symptoms "furnish remarkably positive evidence" in aortic aneurysm: "For instance, pressure wholly and entirely on the right bronchus; congestion of both arms and both sides of the head and chest; tumour symptoms, chiefly about the second space and rib, considerably to the right of the sternum; heart displacement, if any, directly outward; the pulses equal, . . . indicate disease of ascending aorta. Congestion of the left arm, supra-clavicular region, and side of the head; aneurysmal character of right pulse (radial and carotid); tumour symptoms a little to the right of the sternum, and probably some tracheal dyspnœa, are symptomatic of aorta-innominate aneurysm. Modification of left radial pulse, affection of left vocal cord, left venous congestion, tracheal dyspnœa and obstruction of air to both lungs, with tumour symptoms on and to the left of the median line, mark disease of the transverse aorta. Obstruction to the entrance of air to the left lung alone, with pains at the back and along the intercostals, is indicative of disease of the third part of the arch."

4. *Displacement of the Heart Downwards*.—The more marked this is the greater is the probability that the aneurysm is aortic.

Difficulties and Fallacies in the Diagnosis.

1. The proximity of the heart. "When there is a bruit, it is extremely difficult to distinguish whether it is limited to the tumour, or is propagated into it from the cardiac valves."

2. "The growth of aneurysms in the cellular tissue of the mediastinum and root of the neck is so free that instances have been observed of aneurysms of the arch of the aorta causing compression of the subclavian and carotid, without any disease of those vessels; while, on the other hand, if the aneurysm approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased" (Holmes).*

3. The distribution of the branches of the aorta may be anomalous.†

B. Treatment.

I. LIGATURE.‡

Aids in selecting Cases fitted for Operation.—Mr. Barwell (*loc. supra cit.*, p. 520), writing on innominate aneurysms, has formulated the following aphorisms:

i. An aneurysm commencing suddenly, especially if traceable to some over-exertion, is more likely to be benefited by operation than one arising gradually and without mechanical cause. ii. Distinct sacculation is a most desirable condition; fusiform dilatation of the innominate indicates almost certainly a similar condition of the aorta and widespread arterial disease. iii. If symptoms show the aortic arch to be also affected, the disease should be limited—that is, should not extend along the transverse portion. It should be of the sacculated variety, not a general dilatation of the whole calibre. Absence of any other aneurysm, especially of the rest of the aorta, must be ascertained. iv. Absence of rasp-sound along the aorta, or any other indication of extensive atheroma, should be verified. v. Aortic incompetence, unless very slight, is a decided objection, as is also mitral disease, or considerable hypertrophy of the heart. vi. The patency of the vessels leading to the brain should be investigated by making a few seconds' pressure on the carotids alternately and then simultaneously. vii. Absence of visceral disease must be ascertained.

Contraindications to Operative Interference.—Mr. Barwell (*loc. supra cit.*, p. 528) lays down the following: (1) When tumour symptoms reach widely on both sides of the middle line: (2) when, with paralysis of the left vocal cord, there is obstruction of the right bronchus; (3) when there is evidence of considerable aortic incompetence; (4) when there is mitral disease or considerable cardiac hypertrophy;

* *Syst. of Surg.*, vol. iii. p. 14.

† Mr. Holmes quotes the following instructive case: In a patient in whom, from other symptoms, there was no difficulty in diagnosing an aneurysm of the arch of the aorta, one circumstance was difficult to account for—viz., that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death the right subclavian was found to be the last branch of the aorta. Passing between the aneurysm and the spine, it had been compressed, while the carotid was unaffected.

‡ Many of the remarks below apply also to the two other methods of surgical interference—introduction of foreign bodies into the sac and galvano-puncture.

(5) when there is, in the course of the aorta, the rasping sound of calcification or advanced atheroma, more particularly if the superficial vessels are rough and rigid; (6) when there is pain about the spine and intercostal nerves; (7) when there is obstruction of the left bronchus only; (8) when there is pressure on the left apex, and expectoration of frothy blood.

Choice of Vessel. — Question of Simultaneous or Consecutive Ligature.—I have no space here for quoting statistics, which are, after all, of inferior value to the authoritative opinions of those who have worked most at this subject. The earliest and foremost of these is Mr. Holmes; as it is to his opinion that English surgeons will naturally turn, the most important of his views are given here.

1. "One thing, I think, has been fully proved—viz., that the distinction which was so much insisted on between aortic and innominate aneurysm is of less importance in regard to the distal operation than used to be taught, and that a case of innominate aneurysm which otherwise seems appropriate for operation need not be rejected because it is suspected or known that the aorta is also involved. It has also been satisfactorily proved that aneurysms purely aortic have been much benefited by distal operations. It remains to inquire what cases should be selected, and what arteries should be tied in each case."

2. "To my mind the clearest evidence of benefit has been in the case of ligature of the left carotid in the treatment of aneurysm affecting the transverse part of the arch." In a case of this kind it was the evident extension of the tumour up the neck and towards the trachea which made Mr. Holmes think that the ligature would prove beneficial; and the result even surpassed his expectations, the patient being alive and in tolerable health five, and probably seven, years after the operation. Thus Mr. Holmes, considering that the applicability of the distal ligature depends largely on the observed growth of the tumour, would think ligature of the subclavian justifiable if, in innominate or mixed aneurysm, the tumour was making rapid advance under the sterno-mastoid. He also draws attention to the importance of estimating pressure signs as indicating extension of the aneurysm, evidenced by the condition of the veins, the breathing, the pupil, &c. (p. 810).

3. With regard to operations on the right side in cases of innominate or mixed innominate and aortic aneurysm, opinions vary as to whether the carotid or subclavian should be tied simultaneously, or whether the carotid should be tied first. Mr. Holmes, who holds this latter view, evidently thinks that ligature of this vessel may be sufficient without any consecutive ligature of the subclavian, unless indications arise—*e.g.*, the manifest growth of the subclavian portion of the sac, or the effect of compression of the subclavian in diminishing the size or the pulsation of the tumour.

Mr. Holmes' chief reasons for preferring ligature of the carotid alone as a first step are—(a) that while the number of cases of simultaneous ligature is much the larger, the most striking instances of success have followed ligature of the right carotid alone; (b) in some cases, where ligature of the subclavian has been also resorted to later, the aneurysm was already diminishing and becoming firmer after ligature of the carotid; (c) the simultaneous ligature of two such vessels as the

carotid and the subclavian may be a very formidable undertaking from the prolonged dissection and difficulties with the anæsthetic; (d) as ligature of the left carotid has proved sufficient in aortic aneurysm, a similar step should be tried on the right side in innominate aneurysm.

Another interesting and unsettled question bearing on this matter of ligature of large vessels near the heart is **the most appropriate material for ligature**. This has been already discussed (p. 796).

Facts which show that the resort to Ligature has been justifiable.

(1) Solidification and diminution in the size of the swelling. (2) Diminution of pulsation. In one case of Mr. Barwell's (*Med.-Chir. Trans.*, vol. lxxviii. p. 130), a month after simultaneous ligature of both arteries for innominate aneurysm, the swelling again began to increase, and the solidifying tumour to soften, pulsation also recurring; this went on for about two weeks, when the swelling again solidified and decreased, recovery ultimately taking place. (3) Improvement in dyspnœa, dysphonia, and dysphagia. (4) Regain of power over a limb. (5) Expectoration of muco-purulent discharge, which has been accumulating in the lungs owing to interference with expiration from pressure on the trachea.

Very little has been done in the last few years to settle the value of the treatment of thoracic aneurysm by ligature of the large vessels in the root of the neck. Mr. C. Heath (*Brit. Med. Journ.*, Feb. 19, 1898) gave his personal experience of the distal ligature. Where the disease involves the transverse part of the arch, he would be inclined to follow Dr. Cockle's suggestion as regards tying the left common carotid; where the disease involves the ascending part of the arch, Mr. Heath would tie both the right carotid and the subclavian, so as to diminish, as far as possible, the current through the innominate. Owing to the frequent additional embarrassment of breathing brought on by an anæsthetic, Mr. Heath strongly advises the employment of cocaine in all future operations on the large vessels of the neck. Mr. Heath's final summing up of the results, of distal ligature in cases of thoracic aneurysm will meet with the assent of all thoughtful surgeons who are acquainted with the pathology and morbid anatomy of this disease, and with all that surgery has effected: "The results, taken as a whole, are, perhaps, not very encouraging; but it must be borne in mind that, in dealing with a practically incurable disease, a prolongation of life, for even a few months, may be worth attempting."

One of the most recent reviews of the subject of the treatment of innominate aneurysm by distal ligature of the right subclavian and carotid is a critical one by Jacobsthal (*Zeit. f. Chir.*, Aug. 23, 1902). After investigating the results obtained by distal ligature and comparing them with other methods, he shows that the results of this operation do not warrant its performance. The immediate mortality is 55·7 per cent. In Poivet's collection of ninety-four cases, the cures were put down as 7·4 per cent. Jacobsthal has collected twenty-eight more recent cases in which there were no cures, though improvement was found thirteen times.

II. INTRODUCTION OF FOREIGN BODIES INTO THE SAC.—A. WIRE, HORSEHAIR, &c.—This method was originally brought before the profession by Mr. Moore (*Med.-Chir. Trans.*, vol. xlvii. p. 129), who introduced twenty-six yards of fine iron wire into an aortic aneurysm.

No relief followed, inflammation of the sac set in, and the patient died five days later.

Used by itself, this method should be considered obsolete. The theoretical advantages have not been borne out in practice. The chief causes of failure have been the difficulties in introducing a sufficient amount of the filiform material; in the case of wire irritation has often followed, leading in some instances to early rupture of the sac; in that of horsehair and catgut, owing to the readiness with which they bend in the cannula, it is far from easy to get enough into the sac. And even if this were rendered feasible, it is probable that the large amount of foreign material present would interfere with the due contraction of the clot, so essential for the cure of the aneurysm. In some cases, where partial consolidation has been secured, extension has followed in another direction, causing, *e.g.*, urgent tracheal dyspnoea. Further, this method is not without its especial risks.* Combined with galvanism, it is described at p. 817.

B. NEEDLES.—While, for reasons already given, none of the surgical methods employed in thoracic aneurysm can be considered satisfactory, this one, owing to the scientific basis on which Sir W. Macewen has placed it, and its results in his hands, is more deserving of trial.

Suggested by Mr. Moore, it has been tried by Sir W. Macewen, Mr. Heath, and Mr. Puzey (art. "Acupuncture," *Dict. of Surg.*, vol. i. p. 25). Mr. Heath made use of it in a traumatic aneurysm of the subclavian where amputation at the shoulder-joint had failed. Three pairs of sewing-needles were introduced into the tumour, each pair being made to cross in the sac; they were not withdrawn until the fifth day, by which time considerable clotting had taken place. The aneurysm gradually became solid; but bronchitis supervened, and the patient sank seventeen days later. Mr. Puzey followed Mr. Heath's plan in an aneurysm of the innominate, but, no apparent effect taking place at the end of four or five days, other needles were inserted as the first were withdrawn, but at different parts of the swelling. This procedure being carried out for several weeks, the aneurysm finally almost disappeared behind the sternal end of the clavicle. Unfortunately, the needles set up some chronic cellulitis; septicæmia followed with vomiting, and fatal rupture of the sac. Mr. Puzey thinks this case affords a warning against pushing this treatment too far, and that it would be better to wait patiently the results of the first introduction of the needles before proceeding to insert others.

Sir W. Macewen, who used this method first as long ago as 1875, has published (*Lancet*, 1890, vol. ii. p. 1086) a most interesting paper on the use of pins to secure the formation of thrombi, and so the cure of aneurysm.

"The instrument employed is a pin of sufficient length to completely transfix the aneurysm, and to permit of manipulation within it. Its

* I know of one case in which specially prepared very long pieces of catgut were introduced into an aneurysm in the neck. At the necropsy some of these were found to have passed on, beyond the aneurysm, into the splenic artery. In the *Ann. of Surg.*, vol. iv. No. 2, a case of Dr. Ransohoff, of Cincinnati, is recorded, in which ninety-six inches of flexible silver wire were passed into an aneurysm of the aortic arch. After the first forty-eight inches had been introduced, syncope, with impending death, set in. With the aid of stimulants, the operation was completed. For a fortnight the symptoms were improved, when œdema of face and right arm appeared; ninety-eight inches of wire were then passed into another part of the sac. The patient died eight days later, from rupture of the aneurysm. The syncope was found to have been caused by a loop of wire which had passed beyond the neck of the sac into the aorta, where it was probably deflected by the aortic valves.

calibre ought to be as fine as possible, the strength being only sufficient to penetrate the coats of the aneurysm and the intervening tissues. This cylindrical pin tapers to a point, like an ordinary sewing-needle, and has on its opposite extremity a somewhat rounded head. As the coats of aneurysmal sacs vary in thickness, these pins must be made of various calibres. They ought to be finely polished, not only to facilitate their introduction, but to help to render them aseptic. Before performing the operation, the skin over the aneurysm ought to be carefully cleansed and rendered aseptic. The aseptic pin ought then to penetrate the sac and pass through its cavity until it comes in contact with the opposite side. It ought to touch this and no more. Then one of two methods may be employed: either to move the pin over the surface of the inner wall so as to irritate its surface, or to allow the influence of the blood current playing on the very thin pin to effect the same object. If the walls penetrated by the pin be dense, the former method will be preferable, as the force of the blood current produces such a feeble action on the thin pin as to be insufficient to move it to and fro while it is firmly grasped by the dense wall. After acting thus for ten minutes at one part, the point of the pin, without being removed from the sac, ought to be shifted to another spot, and so on until the greater portion of the internal surface opposite to the point of entrance has been touched; this ought to be done in a methodical manner. A single insertion of the pin through the sac into its interior may be sufficient to enable the point of the instrument to come in contact with the greater part of its internal surface; but, in some cases, puncture from various sides of the external wall may be necessary, so as to reach portions of the tumour which cannot be attacked from the first puncture. While the pin is in the aneurysm, it is surrounded by a portion of aseptic gauze, or moistened with an antiseptic lotion. When it is withdrawn from the aneurysm, the part ought to be covered with moist antiseptic dressing, which ought to be maintained for several days. The period a pin may remain in an aneurysmal sac without doing damage is perhaps dependent on the individual, and the state of the aneurysm, but it ought never to exceed forty-eight hours. It is questionable whether all the necessary advantages derivable from the irritation of the wall of the aneurysm could not be produced within a few hours. . . . If the aneurysm be very large, several pins may be introduced from several points, always allowing a considerable interval to exist between each, otherwise there might be too much damage to the vessel wall at one spot. . . . When the pin has been withdrawn, though there may be a little thickening of the tissues in the neighbourhood, there will probably be little or no diminution of the excentric impulse. Occasionally it may be weeks before any distinct or tangible thickening of the coats can be made out. In other instances this may be discernible at a much earlier period. But, as a rule, a distinct thickening of the coat is tangible at an early period."

It will be seen that the aim in Sir W. Macewen's use of acupuncture differs somewhat from that of other surgeons in that his object is to irritate the wall of the aneurysm, the irritation being carried just so far as to set up reparative exudation in the parietes, infiltration of these with leucocytes, and then a further separation of these from the blood current. This irritation is set up at as many points as possible,

so as to produce numerous white thrombi, and so complete occlusion as soon as possible. Of the four cases given by Sir W. Macewen, three are of especial interest in their bearing on the treatment of aneurysm now under discussion.

No. 1 was a case of aortic aneurysm seen at an advanced period when threatened by impending death from dyspnoea. It was treated by the introduction of pins, the first early in December, 1887, this being repeated on seven occasions, with a few days' interval between each. On December 20 dyspnoea reappeared, and, returning on December 31, proved fatal. At the autopsy two-thirds of the aneurysm was filled with a white, firm, laminated thrombus; had the deposition continued at the same rate, it is clear that complete occlusion would have occurred in a few weeks.

Another case was an aneurysm of the abdominal aorta, treated by the same formation of white thrombi; the cure was interrupted by the patient feeling so well that he determined to return to work (engine-driving) after a month's treatment, though the aneurysm was not consolidated. This patient was still alive and in seeming good health when last heard of, two and a half years subsequently.

The third case, which is given in great detail, is the most interesting of all. The aneurysm was here in the thoracic area, probably of the left subclavian, and accompanied by great swelling, pain, numbness, and loss of power in the left arm. Pins were introduced on February 27, March 3, 17, and 24, a gradual thickening of the walls ensuing, as made evident by the greater difficulty experienced in penetrating the coats of the aneurysm, a pin of very fine calibre being used at the onset, some much stouter and more rigid being required later on. During the next four months there was much diminution in the swelling and pain. Pins were again used on five subsequent occasions, but as in two of them it was doubtful if any cavity was entered, their use was discontinued. During the following months there was slow but continuous decrease in the swelling, and the oedema and pain gradually disappeared entirely, the patient being finally able to resume all her ordinary duties.*

It would appear from the above report that an anæsthetic was not needed in any of the above cases—a point of great importance in thoracic aneurysm where dyspnoea and atheroma may be present.

Sir W. Macewen kindly sent me in July, 1895, the following abstract of his later experience:

"I have had three cases of aneurysm treated since I wrote my paper. One at root of neck, subclavian, but involving aorta; cure absolute. One aortic, transverse arch; greatly thickened and improved; patient can go freely about and follow his usual avocation, from which he was debarred prior to operation. One a very large popliteal, in which consolidation took place rapidly, but owing to the great pressure exercised by the aneurysm on the surrounding parts, which was apparently increased by the consolidation, incision had to be made into the sac. Firm, laminated white thrombi were found inside the sac, part of which was turned out to relieve the pressure and to preserve the vitality of the limb. The patient made a rapid recovery, and is now quite well, the remainder of the white thrombus becoming converted into dense fibrous tissue, which subsequently has undergone great shrinking.

"Quite a number of very advanced aortic and abdominal aneurysms have been seen by me, so advanced as to preclude interference. In several an exploratory puncture was made for diagnostic purposes, when the eroded bodies of the vertebrae were felt bare inside the aneurysmal sac. These were not treated.

"I have heard of cases which were so advanced that 'they burst before the pins which had been sent for to treat them with had arrived.'"

* Another very successful case, under the care of Caselli, of innominate aneurysm, treated by Macewen's method, will be found briefly given in the *Revue de Chir.*, 1892, p. 892, and two unsuccessful cases *Glasgow Med. Journ.*, 1891, pp. 280, 453. Sir W. Macewen pointed out (*ibid.*, p. 454) that this method required cases to be carefully selected, and that it was not to be used in those which could not get well otherwise.

III. GALVANO-PUNCTURE.—This method has for its object the production of clotting without the risks and difficulties connected with the introduction of foreign bodies—*e.g.*, wire. Galvano-puncture, the introduction of filiform material, and the merits of these compared with the combined use of electrolysis and introduced wire are discussed in a paper by Dr. Stewart, of Philadelphia (*Amer. Journ. Med. Sci.*, Oct., 1892, *vide infra*).

Points to pay Attention to.—(1) To avoid production of heat, pain, and sloughing of the skin, the current* used should be a comparatively weak one. As an anæsthetic is not usually required, the time occupied may be considerable. (2) The needles should be of steel, as fine as is consistent with perforating the tissues, in order to diminish pain, hæmorrhage, and risk of sloughing. (3) To avoid the same risks, the needles should be insulated within about half an inch of their points by two layers of spirit varnish. (4) As it has been proved that the effect of electrolysis on blood at the positive pole is a fairly firm and tenacious dark clot, while the negative rather produces a pinkish, frothy substance, it seems wiser to connect the needle or needles introduced into the sac with the positive pole, while a large sponge, wrung out of warm salt water, is connected with the negative pole and applied to the chest wall near the swelling. (5) A sitting should not be prolonged over thirty or forty minutes. The punctures had best be closed by collodion. (6) The operation should not be repeated too soon: time should be allowed for all local reaction to cease, and for consolidation of the coagulum to occur, which often takes some time.

Drawbacks and Dangers.—(1) As pointed out by Mr. Holmes, it is a radical defect of this method that it acts by inducing "passive" coagulation of blood in the sac. Hence it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In fact, the cases are few in which a perfectly happy result has been obtained, but some of these are worthy of particular attention.

Amongst these is a case of Ciniselli's (Holmes, *loc. supra cit.*), in which an aneurysm of the ascending aorta, quickly increasing, pushing out the third and fourth ribs, with powerful pulsation, rapidly diminished with much solidification after galvano-puncture for forty minutes, the patient resuming his work as a coachman ten weeks later. In Dr. McCall Anderson's case the aneurysm was a small one, about $3\frac{1}{2}$ inches in diameter; after galvano-puncture on three occasions the swelling was only about one-quarter of its previous size, and for the most part very solid. In a case of Dr. Carter's (*Lancet*, 1878, vol. ii. p. 761), an aneurysm of the thoracic aorta appearing in the right sub-clavicular region, and accompanied by much pain, was treated by galvano-puncture on three occasions with very great relief, the pulsation becoming almost imperceptible and the pain disappearing.

Use of Galvanism through Introduced Coiled Wire.—Dr. Stewart, of Philadelphia, whose experience of the different methods in thoracic

* Dr. McCall Anderson, in a successful case (*Lancet*, 1873, vol. i. p. 261), employed four to six cells of a Stöhrer's battery. In a case of Dr. Ord's (*Lancet*, 1880, vol. ii. p. 450), followed by temporary benefit, six to eighteen cells of a Foveaux's battery were used.

and abdominal aneurysms is a large one, considers the superiority of this combined method over that of introduction of wire alone, or that of mere galvano-puncture, convincingly demonstrated in his papers (*Amer. Journ. Med. Sci.*, Oct., 1892, and *Philadelphia Med. Journ.*, Nov. 12, 1898). "Silver, gold, or platinum wire is undoubtedly the preferable material. The amount required depends upon the calibre of the sac, and must be decided upon with the greatest nicety of judgment, as with too small an amount little or no result will be obtained, and with too great a quantity permanent cure through obliteration of the sac by contraction of the clot cannot be expected. For a globular sac of approximately 3 inches in diameter, I regard from 3 to 5 feet sufficient; for a sac of from 4 to 5 inches, from 8 to 10 feet. How readily these amounts comply with the conditions may be shown by the introduction, through a needle, of a measured amount of spirally wound wire into globular corked bottles of approximately the size stated. The anode or positive pole should invariably be the active electrode. This is connected with the wire, and the negative rheophore, a large absorbent cotton pad, is placed upon the abdomen or back. The current is slowly brought into circuit, and its strength is noted by an accurate milliamperemeter. The increase is gradual for a few moments until the maximum strength supposed to be required is reached. It is maintained at this until the approach of the end of the session, and then gradually diminished to zero, after which the wire is separated from the battery, the needle carefully withdrawn by rotation and counter-pressure, and the released external portion of the wire cut close to the skin, the cut end being then pushed beneath the surface. This is facilitated by using care in the introduction of the needle to first draw the skin at the site of puncture a trifle to one side, in order to produce a valvular opening.

"Experience has shown that the current's strength must be rather high, from 40 to 80 ma., and the session long, from three-quarters of an hour to one and a half hours.

". . . By the application of a strong galvanic current through coils of wire so disposed that all areas of the sac are reached, it follows without exception, as has been noted in all recorded cases, that consolidation by clot formation is promptly and invariably produced. The solidification is rapid, and is generally manifest before the end of the electrical session through changes apparent to the eye and hand in the pulsation and degree of consistence of the sac wall. These changes become more decided in the course of a few days, until, after a time, in the most favourable cases a hard nodule, with a communicated pulsation only, replaces the previous expansible tumour. This was the history of four of the ten cases now recorded."

While, owing to the conditions present in large aneurysms, the most that operative interference can usually promise is some prolongation of life and alleviation of symptoms, there is now sufficient proof that much may be done with the above objects in properly selected cases. The methods which have most scientific basis and which have given the best results are those of Sir W. Macewen and that which should be known as the Moore-Corradi method, advocated by Dr. Stewart. Of these the former is the simpler; the latter gives more points of contact and entanglement for the production of clot.

It is clear, however, that, if anything like prolonged relief is to be given, any operation must be resorted to at an earlier date than has hitherto been the case. Where rapid increase and thinning of the coverings of a large sac are present, together with a wide communicating opening, and where diffuse aneurysmal changes outweigh the amount of sacculatation present, the surgeon who declines to interfere will do wisely. And I would again draw attention to the remarks at p. 809 (a point to which attention has not been sufficiently directed), that surgical interference may, in cases of large aneurysms, do more harm than good by diverting the blood current from the original aneurysm into some outlying and unsuspected secondary sac, and thus cause dangerous and, it may be, fatal pressure on important parts which have hitherto escaped. Besides this danger, three other chief ones have to be remembered when wire is introduced. (1) Embolism. (2) Suppuration of the sac. Both these have been made much rarer by carefully rendering the wire aseptic. Any inflammation of the sac should at once be treated by ice-bags. (3) Introduction of the wire, &c., beyond the aneurysm, and consequent especial risks (footnote, p. 814).

PART III.

OPERATIONS ON THE THORAX.

CHAPTER I.

REMOVAL OF THE BREAST (Figs. 277 to 294).

Indications.—The following remarks must be considered to refer to that most common and important of diseases—carcinoma.

Removal of the breast is an operation which deserves most careful attention, on the following grounds—viz., the frequency and the distressing nature of the results of malignant disease here, and the fact that, while there is reason to hope that the operation is becoming more successful, much still remains to be done. Women will always be unwilling to make known their fears here, on account of a natural delicacy; but another reason leads them to conceal the earlier stages of a growth (in which alone it can be thoroughly dealt with), and that is the well-known want of permanent success which too often follows operation. Precious time is also still too often lost by the medical attendant when he is consulted, in some cases from a mistaken kindness and desire to make light of fears, in others from a disbelief in the value of operation here.

Here, as in all cases of malignant disease, early and thorough operation* is needed. With regard to the latter, the limits of wide and thorough operating have probably been reached, but can it be said that the patients are submitted to operation as early as might be the case? Is it not rather the truth that in the majority of cases the operating surgeon does not get his chance until the disease has had time to pass beyond its first stage, and to spread to parts outside the breast itself, as evidenced by the adhesion to the skin and by the

* While on the subject of operating thoroughly and on wide lines, I would quote some words of Mr. Bennett May in his Ingleby Lectures (*Brit. Med. Journ.*, May 29, 1897, vol. i. p. 1338)—words weighty from their outspoken truthfulness: "The operation in too many cases is not practised to the best advantage, and is not used for all it is worth. Certainly some of the disrepute and prejudice which have surrounded it may fairly be ascribed to the incomplete and inadequate manner in which it is too often done by men who have had no proper surgical training, and whose ill results serve to injure the cause as a whole, and to reflect prejudicially on the work of others. The fact is, it has been

glands found affected when the axilla is opened? * While in malignant disease of the sexual organs we shall always have to deal with a larger proportion of late cases than elsewhere, there is no doubt that we should diminish the number of these late cases if both the patients and the general practitioners who are first consulted realised more clearly, and if the latter impressed more strongly on their patients—(1) that there are, every year, an increasing number of patients who are living in good health several years after the operation; (2) that the operation, while serious, is not a dangerous one; (3) that if the disease does recur after the improved operation of the present day the recurrence will be delayed; (4) that the operation of the present day promises much better results, but that these results will only be secured by the operation being an early one—*i.e.*, while the disease is in its first stage, and limited to the bosom; (5) that in this first stage, in which operation is so essential, there is an entire absence of pain, or of much or anything to see: thus, a “lump” must not be neglected because it is painless, as is so often the case; (6) that, when in doubt as to whether a persisting “lump” which he is examining is carcinoma in its first and quiescent stage, or induration, or a deeply lying cyst with thick walls, the general practitioner should consider it his duty to have the “lump” excised at once (*vide infra*), and the breast dealt with as may prove necessary.

Results and Dangers of the Improved Operation for Removal of Malignant Disease of the Breast.—I. Mortality of the Operation.

II. Results of the Operation.

I. Mortality of the Operation.—Recent statistics clearly show that though the severity of the operation has been much increased, its mortality is, *under the best conditions* (*vide infra*), very low. Thus, Sir W. M. Banks (*Brit. Med. Journ.*, 1900, vol. i. p. 823) gave a series of sixty operations without one death. Dr. Halsted (*Annals of Surgery*, Nov., 1894, p. 512) states that fifty of what he terms “complete” operations had been performed at the Johns Hopkins Hospital, Baltimore, and not a death had resulted from these operations. Mr. Watson Cheyne (Lettsomian Lectures, 1896, *The Objects and Limits of Operations for Cancer*, p. 34) had only one death in sixty-one cases, and thought that “the ether had probably as much to do with this death as the operation.”

With regard to this very low mortality, it must be remembered that such results are the work of men of special experience; that cases in private as well as in hospital practice are included; and, lastly, in Dr. Halsted's case, the operator was working with very highly trained assistants.

When due attention and weight are given to such conditions as shock in an obese patient with poor cardiac fibre, lung trouble in a

everyone's operation because it has been thought to be easy.” While the need of doing justice to this very common operation is being enforced, I would draw especial attention to the urgent necessity of *doing justice to the first operation* (p. 858).

* Dr. L. S. Pilcher, whose opinion is always valuable from his thoughtfulness, mature experience, and candour, thus expresses himself (*Annals of Surgery*, Sept., 1903):—“It cannot be too strongly emphasised that practically every case of carcinoma of the breast, when it has reached that degree of development by which a palpable tumour is formed, is already in an advanced stage, such an advanced stage that, as a rule, metastatic deposits have already begun to be formed.”

patient with chronic bronchitis, unavoidable infection as from an ulcerated* growth, the readiness with which this operation is undertaken, and the personal equation of the skill of the operators, it will, I think, be admitted that if all fatal cases were published, the death-rate would not be so low as that above given. It has, however, proved what can be done *under the best possible conditions*. But I would impress on my younger readers that it is not infective causes only which, nowadays, kill these patients; it is causes which, even when foreseen, no amount of care and caution will always prevent when an operation is pressed upon us. I allude to bronchitis after an anæsthetic when the chest is hampered by bandages, and the patient, scarcely answerable for her actions, persistently slips down in the bed; to the failing strength and vitality with which the flickering light of the life of a patient with a fatty heart or albuminuria is snuffed out, it may be two or three weeks after the operation. The severity itself of operations rarely brings about a fatal result, unless the patient prove unamenable, another condition against which it is extremely difficult to guard.

II. Results of the Operation.—It is clear, from the statistics which have been furnished (*vide infra*), that from 40 to 50 per cent. of patients submitted to the improved operation will be alive and apparently well three years and more after the operation. By many surgeons, some of them of eminence, this is looked upon and spoken of as tantamount to a cure (*vide infra*).

Dr. Halsted (*Annals of Surgery*, Nov., 1898, p. 575) had operated on 133 cases by his improved method between June, 1889, and April, 1898. Of these 133, 76 had been operated on more than three years. Of these 76 operated on more than three years, 31 (41 per cent.) were living at the time of publication of the above article, without local recurrence or signs of metastasis.

Mr. Watson Cheyne, C.B. (*Lancet*, 1904, vol. i. p. 701) from his private cases which he was able to trace concludes that "from 50 to 55 per cent. of the cases are alive and well after periods varying from six to thirteen years."

Mr. Butlin (*Operative Surgery of Malignant Disease*, 2nd ed., p. 404), from a collection of 47 cases operated on by Dr. Halsted, himself, Mr. Watson Cheyne, and Rotter, gives a percentage of over 50 cases "cured," *i.e.*, alive and well three years or more after the operation.

Sir W. Mitchell Banks (Lettsomian Lectures, "Practical Observations on Cancer of the Breast," *Brit. Med. Journ.*, vol. i. 1900, p. 823) tabulates 213 cases, "of which 175 are available for statistical comparison. Of these 175, 108 have remained free from local recurrence. Of these 108, 73 have lived over three years, as follows:—

Cases that have lived between 3 and 6 years after operation	.	.	.	40
" " " 7 " 14	"	"	.	28
" " " 16 " 12	"	"	.	5

* Mr. Lockwood has drawn attention (*Traumatic Infection*, p. 51) to the grave importance of an ulcerating carcinoma as a dangerous source of septicæmia during the operation for removal of the breast. In his opinion (*loc. supra cit.*, p. 63) swabbing over the surface of the ulcer with pure carbolic acid is not always reliable, and he would advise destroying the entire surface of the ulcer with the actual cautery.

With regard to the results of operation, I must here again utter a caution, which I believe I was one of the first in this country to bring forward (in the third edition of this book), as to the use of the word "cure" in these cases. For some time past there has been an increasing tendency for leading surgeons, both English and American, to adopt Volkmann's teaching, and if three years have elapsed after an operation for malignant disease without recurrence, to look upon the patient as cured, and to speak of these cases as "cures." Such surgeons make light of any inaccuracy which it is admitted may be present in the above dictum, and they claim that, being "optimists," such a dictum is quite good enough for them, and that any other surgeons who hold a different view are to be looked upon as "pessimists." Now, there is one thing which is above optimism and pessimism, and that is the truth. What is the truth in this matter? It turns on what we understand by the word "cure," and—a matter of even greater importance—what our patients understand by it. No one, to my knowledge, has spoken to better purpose on this point than Mr. Sheild (*Med.-Chir. Trans.*, 1898, and *Diseases of the Breast*, p. 448): "As regards the prospect of a definite cure, as the term is understood by the public—i.e., definite eradication of the disease, leaving the organism in a healthy state—it is the duty of a conscientious surgeon to be exceedingly cautious in pronouncing such definite opinions as have emanated from the German schools." And again, at p. 437: "Fresh manifestations of the disease locally, or in the bones or viscera, may occur at any period up to ten or fifteen years after the original operation. These may be termed fresh outbreaks of the disease, or what name any pathologist fancies, but the fact remains that the word 'cure' will be used with great caution by anyone who views the matter from the light of plain common sense, and a desire to act truthfully and conscientiously towards patients."

Being myself well aware of the variableness of cancer in its original rate of growth, its occasional long latency and then sudden reactivity, I look upon Volkmann's teaching as most pernicious, and on the adoption of his teaching—that if patients remain free for three years after an operation for malignant disease they may be looked upon as cured—as alike unscientific and dishonest, and unworthy of our profession. As Sir W. Bennett in the discussion on Mr. Sheild's paper (*loc. supra cit.*) very forcibly put it: "It is perfectly certain that we cannot in any case of cancer promise what the patient understands by the term 'cure.' I cannot, therefore, escape from the conviction that if we are to use deliberately the term in relation to a three years' immunity from disease, we shall forfeit, I think deservedly, a great deal of that reputation for candour and honesty which we now possess."

Local Recurrence, when it occurs, is delayed by more Extensive Operations.—While we cannot honestly hold, without watching longer and publishing later the results of recent operations, that patients can count on a cure of the disease, there is no doubt that local recurrence is less frequent, and when it does take place it is delayed, especially when the light treatment is called in to our aid. Mr. Watson Cheyne put this matter strongly in his speech at the discussion on Mr. Sheild's paper: "After the Heidenhain-Stiles operation external recurrences

have become much rarer, and in the majority of cases there is practically nothing left for the patient to die of but the metastatic deposits; and, further, in the absence of external recurrences, the patients live longer, and the internal deposits have time to grow and to become more noticeable." Here the essential proviso must be remembered. The results just mentioned can only be secured after a wide operation, performed by competent hands.

To ensure such improved results the following conditions are essential:

A. To operate widely and thoroughly, and thus to endeavour to remove every atom of tissue which recent researches have shown may be the seat of disease. This will include (i.) removal of the whole breast, which the facts given below will show to be far from as easy as it is often thought to be; (ii.) removal of the costo-sternal portion of the pectoralis major, and, if advisable, the pectoralis minor also; (iii.) clearing out the axilla; and (iv.)—this is as important as any—the breast, the pectoralis major, axillary fat and glands, should be removed in one continuous mass.

B. To exercise as far as possible a careful and judicious selection of cases.

C. To keep patients under supervision for a long time, and, at first, to see them at short intervals.

A. The operation to be wide and thorough, in order to remove every atom of tissue which may be diseased.

(i.) Removal of the Whole Breast.

Advocating, as I do most strongly, for reasons given above, the habitual performance of operations for malignant disease on the widest possible scale consistent with the patient's safety, I would draw attention to the following practical points bearing on the breast and the way in which carcinoma attacks it, which have been brought into prominence in recent years. (a) The breast is, in reality, a much more extensive organ than is usually believed. In addition to the well-known prominence, there is often a ring of outlying gland-masses of varying size and extent. Mr. H. J. Stiles, in a most helpful paper (*Edin. Med. Journ.*, June and July, 1892), thus alludes to the latter point: "The breast tissue is not encapsulated into a compact body, but is so broken up and branched at its periphery that the stroma becomes directly continuous with the superficial fascia. There is, therefore, no capsule in the ordinary sense of the term." (b) The ligamenta suspensoria may contain breast tissue and lymphatics. Both these facts make clear the futility and risk of niggardly skin incisions. (c) There are often lobules of breast tissue intimately connected with the pectoral fascia.* These are certainly left behind if the breast is merely separated from the pectoral fascia, as used to be done. (d) A

* As will be shown later (p. 836), Mr. Handley is of opinion that "the use of the expression 'removal of the pectoral fascia' instead of 'removal of as wide an area as possible of the deep fascia' and the exclusive attention paid to the axillary glands as the channels of dissemination have led to neglect in the excision of the deep fascia over the lower part of the thorax and the upper part of the abdomen."

deep lymphatic plexus or lymph path runs in this fascia from the breast towards the axilla. Volkmann was the first to teach prominently that it was right to remove entirely the pectoral fascia. Prof. Halsted thus quotes from Volkmann's *Beiträge zur Chirurgie*: "I was led to adopt this procedure because, on microscopical examination, I repeatedly found, where I had not expected it, that the fascia was already carcinomatous, whereas the muscle was certainly not involved. In such cases a thick layer of apparently healthy fat separated the carcinoma from the pectoral muscle, and yet the cancerous growth, in places demonstrable only with the microscope, had shot its roots along the fibrous septa down between the fat lobules, and had reached and spread itself out in flat islands in the fascia. It seems to me, therefore, that the fascia serves, for a time, as a barrier, and is able to bring to a halt the spreading growth of the carcinoma."

The above points in the structure of the bosom, which explain how easily outlying and deeply placed deposits of carcinoma may escape niggardly and superficial operations, will explain many of the steps enjoined below in the account of removal of the breast.

Mr. Stiles (*loc. supra cit.*) believes that "local recurrence of carcinoma after removal of the breast is usually due, not to the rest of the breast being in a pre-cancerous state, but to the non-removal of small and often microscopic foci of cancer, more or less remote from the main tumour, and depending for their origin upon the arrest and growth of cancerous emboli disseminated more or less directly from the primary tumour along the lymphatics.* The importance of removing all the retro-mammary tissue, pectoral and axillary fascia, the axillary fat and glands, along with the breast, in all cases of carcinoma, cannot be too thoroughly insisted upon or too often repeated. The anastomosis and intersection of the lymphatics are so free that it is impossible to say towards which set of glands the lymph from any given point in the breast will be conveyed. I have seen cancerous lymphatic emboli at the axillary border of the mamma when the tumour was situated in the inner hemisphere, and *vice versa*."†

The following cases, from an important paper by Mr. Raymond Johnson, read before the Pathological Society (*Brit. Med. Journ.*, 1892, vol. i. p. 70), illustrate how unsafe it is to leave any portion, however small, of a breast the seat of malignant disease, not only, as shown by Mr. Stiles, on account of the frequent presence of minute foci of carcinoma, remote from the main growth, but also because changes of

* Mr. Stiles's observations lead him to recognise five sets of lymphatics in the bosom: (1) a cutaneous set, including those of the nipple-areola and surrounding skin; (2) sub-areolar; (3) intra-mammary; (4) in the circum-mammary fat; (5) retro-mammary.

† In order to afford the surgeon an additional means of ascertaining the limits of the breast and of the disease, Mr. Stiles (*loc. supra cit.*) recommends the use of nitric acid, which, rendering the parenchyma of the gland and carcinomatous tissue dull greyish-white and opaque, causes the smallest specks of both to stand out from the fat and connective tissue in which they are embedded, the fat remaining unaltered and the connective tissue becoming translucent and somewhat gelatinous. Immediately after removal the breast is placed (all the blood being first washed off) in from one to two pints of a 5 per cent. nitric acid solution for about ten minutes, and then washed in running water for three or four minutes. This examination can be completed before the wound is sutured.

a "pre-cancerous" nature may be going on in parts of the breast not yet actually attacked by carcinoma.

In a case of infiltrating carcinoma in a woman, aged 27, microscopical examination of parts of the breast, which appeared normal to the naked eye, revealed masses of carcinomatous cells apparently lying in lymphatic spaces. In another specimen of the infiltrating variety the microscopical appearances strongly suggested that widespread carcinomatous change was involving the whole organ, sections showing the new growth arranging itself around the small ducts, which were themselves normal. In the case of a woman, aged 34, a small nodular carcinoma was situated at the axillary border of the left breast. After removal two small nodules were found at the sternal end of the gland, each having the typical structure of glandular carcinoma, whilst microscopical examination of the central part of the breast showed marked proliferative changes in the epithelium of the acini, these changes probably standing in the same relation to carcinoma of the breast as chronic superficial glossitis does to epithelioma of the tongue, namely, a possible "pre-cancerous" condition.

Heidenhain, in a most valuable paper ("Ueber die Ursachen der localen Krebsrecidive nach amputatio Mammæ," *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, Berlin, 1889), teaches that in carcinoma of the breast there are proliferative changes in the lobules throughout the whole gland, which must be looked upon as the direct forerunner of carcinoma ("das mittelbare Vorstadium der Krebsentwicklung"), and which sooner or later pass into this disease.

On this account, believing that, whether the whole breast is, in the great majority of cases, in a condition to become carcinomatous or not, partial operations are liable (especially when the coarse fat, which is often so abundant, and the hæmorrhage in the operations are remembered) to leave behind potential foci of disease, I consider that the more wholesale operations are, in these days of modern surgery, absolutely essential.

(ii.) **Removal of the Costo-sternal Part of the Pectoralis Major and the Pectoralis Minor.**—The need of the latter step is disputed. Dr. Halsted in every case removes the whole thickness of the pectoralis major except its clavicular portion, and divides in all, and in most cases removes, the minor as well. His reasons are as follows:—(a) It has been microscopically proved by Volkmann and Heidenhain that repeatedly a carcinoma of the breast, though freely movable on the subjacent parts and separated from the muscle by a layer of fat apparently healthy, has reached and spread out in the fascia over the pectoralis major. Removal of the costo-sternal part of the pectoralis major is the surest method of getting quickly rid of this fascia. (β) It facilitates the removal of the disease in one piece, which is so essential (*vide infra*, pp. 828, 854, and Fig. 293). (γ) This step does not increase the danger of the operation; that this is so in Dr. Halsted's hands is shown by the very low mortality in his paper (*vide supra*), published in 1894, viz., 76 cases without one death. (δ) The impairment of usefulness of the upper extremity, due to the operation, is but little increased by the above step. "In most cases the arm of the side operated upon has been quite as useful as before the operation. Some of the patients, when questioned, complain that they cannot dress their back hair.

This disability is due to the loss of skin, and not to the loss of muscle." The above small impairment of usefulness Dr. Halsted attributes to his securing primary union of the axillary end of the wound, and thus an absence of fixation of the arm to the side, by his flap (Fig. 291). With regard to those cases in which there is some impairment of usefulness, all will agree with his remark: "After all, disability, ever so great, is a matter of very little importance as compared with the life of the patient."

With regard to the pectoralis minor, Dr. Halsted always divides this, and sometimes removes it, because "the tissue over it, more or less rich in lymphatics, is often cancerous," and because under it run small blood-vessels embedded in loose connective tissue which seems to be rich in lymphatics and contains more or less fat. This fat is often infiltrated with cancer."

On this point of how far the mobility of the arm is impaired I would refer my readers to Fig. 294, taken from a case of mine in which both breasts and both pectorals on each side had been removed.

Authorities are now unanimous as to the removal of the greater part of the pectoralis major.

Mr. Watson Cheyne, C.B. (*Lancet*, vol. i. 1904, March 12, p. 700), considers it advisable to take away practically the whole of the sternal portion of the pectoralis major. As to removal of the pectoralis minor, he removes this muscle where there is much glandular infection, as the nerve supply is almost certain to be injured. Where the axillary glands are not much affected, and where the nerve supply can be preserved, he generally leaves the pectoralis minor, as the axilla can be quite well cleared without taking it away. For myself, knowing that in the majority of cases carcinoma of the breast is not brought to the operator until it is no longer limited to the breast itself, feeling also that the growth may have invaded the sheath though the fat over this appears healthy (p. 825), that it may also have invaded the muscle itself though invisible to the unaided eye, having found that for myself a free removal of the muscle facilitates clearing out of the top of the axilla, and feeling that though this free operating leads to a thicker, wider scar, and therefore in some cases to impaired abduction and elevation of the arm, this must not weigh against any step that may help in extirpation of the disease, I advocate entire removal of the costo-sternal portion of the pectoralis major in all cases. And I would add here that the fascia over the serratus magnus should be removed as well, especially in those cases where the chief disease is situated over the lower and outer part of the pectoralis major, where the coverings of the chest wall are becoming thinner. When the patient is feeble, or has chronic bronchitis and a weak heart, the decision as to removal of the costo-sternal part of the muscle will depend upon the way in which the anæsthetic is taken, the condition of the pulse, and the amount of skilled help that is to hand. For free removal of the above part of the muscle leads to additional hæmorrhage and to some increase of the shock.

As to removal of the pectoralis minor, I agree that when this muscle is but little developed, as is usually the case, the axilla can be cleared out, by efficient use of retractors, without division of the muscle. But the fatty cellular tissue over and under it is so delicate, and, on Dr.

Halsted's authority, is so liable to be infiltrated, that removal of the muscle certainly facilitates clearing this tissue away thoroughly. Removal of this muscle will not increase the impaired mobility of the arm, but it does leave a deeper, more irregular floor to the wound, in which discharges may collect if it be not left dry. For the same reason immediate grafting is rendered less easy—a matter of minor importance, as it is wiser to defer this step if it be found needful (p. 848).

(iii.) **The Need of Clearing out the Axilla in Every Case.**—This has been increasingly accepted of late years, and is now almost universally acted upon. It is acknowledged that the axillary glands may be extensively involved without any external evidence; nay, more, the microscope has shown that axillary contents, apparently normal to the unaided eye, have been the seat of extensive carcinomatous deposit. We know now that opening and clearing out the axilla does not add to the risks of the operation as long as due precautions against infection are taken. Cases are still occasionally quoted in which, though the axilla was never opened, the disease has not appeared there for many years, as long as the patient was kept under observation. The answer to this, as an argument against a routine practice of clearing out the axilla, is very simple. We must admit that such cases exist, but they are extremely few. Possibly, in 100 cases in which the axilla has been cleared out as part of the thorough operating of the present day, in four or five this step might be superfluous, as the disease had not reached the glands. But which of the 100 were these four or five? Does anyone pretend for a moment that our knowledge of carcinoma of the breast enables us to select them before operation? (Watson Cheyne).

(iv.) **The Whole of the Disease should be Removed in One Continuous Piece** (Fig. 293).—The following are Dr. Halsted's words (*Annals of Surgery*, Nov., 1894, p. 507) on this point, and it will be seen that to achieve this object is one of his chief reasons for removing the pectoralis major:—"The pectoralis major, entire, or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled thereby to remove in one piece all of the suspected tissues. The suspected tissues should be removed in one piece (1) lest the wound become infected by the division of tissues invaded by the disease, or of lymphatic vessels containing cancer cells, and (2) because shreds of pieces of cancerous tissue might readily be overlooked in a piecemeal extirpation." And again, at p. 510: "All that is removed is in one piece (Figs. 292 and 293); there are no small pieces or shreds of tissue. . . . The division of one lymphatic vessel and the liberation of one cell may be enough to start a new cancer."

Sir W. M. Banks (*Brit. Med. Journ.*, vol. i. 1900, April 7, p. 822) dissented from the above opinion: "A view is now being taught that there is great danger of infecting the wound with the knife that has made the exploratory incision through the tumour. I have seen no evidence whatever to this effect, and the extreme difficulty of getting the strongest cancer-juice to reproduce anything in any cultivation medium is not in favour of it. If the operator is afraid of such a contingency let him wash his knife."

With all deference to the authority of the late Sir W. M. Banks, I am of opinion that as we know so little of the causation of carcinoma, and as the proportion of the cell elements in cancer varies so much, we shall do well to adopt every possible precaution.

B. A careful and judicious selection of cases.

I. Cases in which an Operation is Indicated.—(1) Cases somewhat advanced in life; for the younger the patient the more active is the cancer. (2) Especially if patients who are on in years are thin and dry and tough, clear-voiced and bright-eyed, with good pulses and digestion, and no cough or wheezing. (3) Small breasts and little fat. (4) Where the growth is circumscribed with a distinct outline. The least defined tumours are the worst for recurrence. (5) Where the growth is very hard. The "stoniest" growths are usually the slowest. (6) Skin not involved. (7) Absence of fixity. (8) Either no axillary glands, or but very few, involved. (9) Rate of progress slow, and family history good.

II. Cases to which an Operation is altogether Unsuitable, or especially Doubtful and (in many) Dangerous.—(1) The aged—*e.g.*, after seventy; not only are the aged less healthy, but they are less troubled by the disease, and more resigned. (2) The unhealthily fat* and plethoric. (3) Habitual over-eaters. (4) Tipplers on the sly. (5) The subjects of a confirmed bronchitis and weak heart. (6) Subjects of decided albuminuria, cirrhosis, or diabetes. The first two of these should prohibit operation. Where glycosuria is present the prognosis will depend on how far the amount of sugar is affected by treatment. Where treatment has no effect, and where the operation must be an extensive one, it must be clearly put before the patient and her friends that the risks are much increased. I allude to diabetic coma, the increased shock, and the risk of infection from sloughing, in such a case, of flaps freely undermined. Mr. Sheild (*Diseases of the Breast*, p. 422) speaks more hopefully: "In cases of glycosuria extra pains must be taken to avoid sepsis. If this be done, the sugar in the urine is no bar to a needful operation, though it must of necessity make the prognosis more serious, and this must be especially stated." (7) Extensive disease of the skin, accompanied by scattered tubercles, or œdema, or a condition of erythema (this is the "cancer-erythema" to which Mr. J. Hutchinson has drawn attention), and, worst of all, a brawny, leather-like, greasy condition of the skin, with firm œdema and open sebaceous glands, approaching the condition of cancer *en cuirasse*. (8) Quick growth, with rapidly increasing fixity. (9) Supra-clavicular disease. When this condition is present the general opinion of surgeons has been that the disease has taken too extensive a hold,

* Sir James Paget, from whom many of the above have been taken, thus wrote (*Clin. Lects. and Essays*, p. 14): "The over-fat are certainly a bad class, especially when their fatness is not hereditary, but may be referred in any degree to their over-eating, soaking, indolence, and defective excretions. The worst of this class are such as have soft, loose, flabby, and yellow fat; and I think you may know them by their bellies being pendulous and more prominent than even their thick subcutaneous fat accounts for, for this shape tells of thick omental fat and, I suppose, of defective portal circulation." Some earlier remarks of Sir James may here be quoted: "Such people must be carefully managed—not fed too well; not kept too long in bed; not allowed to retain their refuse; and mere bigness must not be taken for plethora."

and that operation is useless. Dr. Halsted's rule (*Annals of Surgery*, Nov., 1898, p. 570) would be to operate on the neck in every case.* This operation is not postponed, as it can never be done so well as at the first opportunity when the axilla is opened, the subclavian vein fully exposed, and the clavicle free. This bone is not now divided as in former years, "for simple division of the clavicle does not facilitate the dissection much, if any, and the removal of a piece of the collar-bone is a procedure which maims without sufficient compensation." The dissection is begun at the junction of the internal jugular and subclavian veins, and the supra-clavicular fat and lymphatics cleared away by working from within outwards and from below upwards. The great majority of surgeons are against this step. Sir W. M. Banks (*loc. supra cit.*, p. 821) wrote: "I have given up attempting to get any good out of clearing out the supra-clavicular fossa. In former days, when I thought I could remove any cancer, I did a good many cases, but never one survived. . . . My notion is that when cancer has laid hold of the supra-clavicular glands it has got such a grip as to be past extirpation." Mr. Butlin's opinion (*Operative Treatment of Malignant Disease*, 2nd ed., p. 399) is as follows: "I have not been in the habit of removing the supra-clavicular glands, certainly not as a routine part of the operation for cancer of the breast. The operations which are now performed are so extensive that any addition to them is fraught with danger. If the glands above the clavicle are to be removed, I think it would be wiser to do this when the patient has recovered from the larger operation. If they are actually cancerous, I believe that the case is hopeless as far as radical cure of the disease is concerned. And that is an opinion which is shared by most operators at the present time." Mr. Watson Cheyne (*Lancet*, vol. i. 1899, p. 757) would only clear out the posterior triangle if he found the fat which runs up behind the axillary vessels and nerves in the direction of the posterior triangle infected with enlarged glands. If the glands behind the sterno-mastoid in the root of the neck are implicated—and this is much the most common glandular infection in the posterior triangle—he would not interfere, "as the results do not justify operation." Writing a few years later (*Lancet*, 1904, vol. i. p. 700), Mr. Cheyne would open the posterior triangle if any enlarged glands are felt there, or if in clearing the axilla infected glands are found high up. Marked enlargement of the supra-clavicular glands in his opinion "renders the case inoperable from the point of view of radical removal." My own view on this matter is, that where the supra-clavicular glands are enlarged a radical cure is out of the question. The only evidence of any value which we learn from Dr. Halsted's statistics† on this point is that two of the cases in which the supra-clavicular region was

* *I.e.*, whether enlarged glands can be felt or no. His statistics are quoted a little later.

† The supra-clavicular fossa was cleared out in 67 cases, 53 being primary and 14 secondary operations. Of the 53 primary operations, in 12 the supra-clavicular glands were involved; of the subsequent history of these we are told nothing. Cancer was found in the tissues removed 23 times, or in 34 per cent. of these cases. In 30 cases there was no cancer, and in 14 the result was uncertain, as the tissues removed had not, at the time of publication of Dr. Halsted's paper, been submitted to the regular exhaustive examination which his specimens undergo.

cleared out were alive and well three and three and a half years respectively after the operation on the neck, which was here a secondary one.

With regard to these statistics the following remarks by Dr. Coley in his article on Cancer (*Twentieth Century Practice of Medicine*) are noteworthy: "The only positive evidence Halsted's statistics afford us as to the value of this operation of cleaning out the supra-clavicular fossa rests upon two cases in which the operation was done secondarily, and in which the patients remained well three and three and a half years after the operation. In view of what I have already said regarding the failure of a three-year limit as establishing a cure of the disease, we cannot consider the question as settled without much stronger evidence."

To those who agree with what I have said about the value which, in my opinion, is to be attached to this three years' limit of Volkmann's (p. 823), it will be clear that much more evidence is required before we can come to a conclusion on this matter. But there is one point which appears to me to be negative success, and that is, that in dealing with disease here it is impossible to follow the cardinal rule on which Dr. Halsted has himself laid so much stress, viz., to get out the disease in one continuous piece. Where the disease has reached only a few of the axillary glands, and these the lower ones, careful operating on wide lines may succeed in extirpating it in its continuity. But where it has extended above the clavicle, I believe that it is impossible to follow the above most essential rule. There will always be an infected lymphatic tract running between the two regions behind the clavicle, and even removal of this bone—itsself no slight operation—will not enable us to extirpate the above tract, considering what its relations are, however carefully the dissection is carried from below and above, and however much the shoulder is raised and depressed.* But, while I believe that radical cure is hopeless when the supra-clavicular glands are enlarged, I consider that operation is justifiable, both as a primary and a secondary step, if the object of the operation be honestly explained to the patient or her friends. I have myself twice performed it, in both cases as a secondary operation. In one case the patient lived three years, in the other fourteen months, after the operation. Glands in this space will, I believe, usually be found to enlarge slowly, and, as the space is relatively large, they do not become adherent quickly. If the operation is a primary one, it should not be performed at the same time as that for removal of the breast, but from ten to twenty-one days later. Clearing out the posterior triangle is a difficult and trying operation, especially in its lower and inner regions, and, both for the patient's and surgeon's sake, it should not follow at once on an operation like the modern one for removal of the breast. I am aware that Dr. Halsted (*loc. supra cit.*) undertakes both these operations, together with Thiersch's grafting, when this is needed, at one and the same time. "Two to four hours" are required, but it is to be

* It is the same with cancer of the tongue when the glands in the neck are invaded. I have long taught that radical cure is here almost hopeless, owing to the great difficulty in extirpating the lymphatic tract which lies behind the jaw and in the floor of the mouth. It is noteworthy that Mickulicz (*Twentieth Century Practice of Medicine*, vol. ix. p. 79) wrote on this point: "I regard the prospect of radical cure as excluded as soon as the deep glands of the neck become invaded."

remembered that he can always count on "highly trained and skilful assistants." (10) A young patient, especially with a voluminous breast, a rapidly increasing growth, and a bad family history. (11) Of course, the presence of carcinoma elsewhere—*e.g.*, uterus—or secondary deposits in the liver, pleura, and bones. Mr. Sheild's advice (*Diseases of the Breast*, p. 393) should be remembered: "Vague pains, supposed to be 'rheumatic,' should always lead to an examination of the bones, and the contents of the thorax and liver should receive methodical investigation." That operation is not absolutely contraindicated where both breasts are involved is shown by a case of Mr. Page's (*Brit. Med. Journ.*, 1888, vol. ii. p. 937):

Here both breasts were the seat of carcinoma, and both were simultaneously operated on by Mr. Page and Mr. Silcock. The patient, aged 68, made a good recovery. The case of mine illustrated in Fig. 294 may also be referred to.

(12) Cases in which the axillary vessels and nerves are clearly involved in a mass of growth. (13) Pregnancy and suckling. When these complications are present in carcinoma of the breast two questions arise. One refers to the diagnosis. In these cases the carcinoma is likely to be associated with evidence of inflammation, and to be mistaken for acute mastitis. The following points should be investigated: "The skin has a peculiar erythematous blush upon it (cancer-erythema, Hutchinson), which spreads over the skin of the mamma and thorax, gradually fading off into the surrounding tissues. There is local heat and tenderness, and the temperature is raised. A close inspection of the skin usually declares the true nature of the case, for it is infiltrated with carcinoma over the breast, and has invariably the '*peau d'orange*' appearance. The lymphatics of the integument may be markedly implicated, so that they stand out as white cords and nodules of a yellowish or white and pearl-like aspect" (Sheild, *Diseases of the Breast*, p. 358). With regard to operation, the prognosis* is extremely unfavourable when the patient is either pregnant or suckling. If the patient be comparatively young, there is much vascularity and activity of the lymphatic circulation, and hence a very high degree of malignancy. However free the removal, return in the adjacent area is extremely probable, together with secondary deposits. If the patient survive, the other bosom may not improbably be attacked. The outlook should be put before the patient. If operation be decided upon, the risks of abortion or premature labour must be faced.

III. *Cases in which an Operation is Doubtful.*—These lie intermediate between I. and II., both as to the general and local points.

Operation† (Figs. 277—294).—The chief objects to be borne in mind throughout the operation have been given at p. 824.⁵²

* There are no worse cases for operation than those in which malignant disease supervenes on mammary abscess and induration in suckling women. The more vascular the breast and the more abundant the fat, the more difficult will it be to make certain of extirpating not only the growth, but also every atom of the breast. Speaking of vascularity, I have been asked if removal of the breast is justifiable in hæmophilia. My answer would be a decided negative.

† By some the above operation is called "the complete operation." Till the cases submitted to it have been watched for a much longer period than three years, the period too often considered sufficient (p. 823), it will be wiser and more honest not to write of operations on cancer as complete. By others the operation is described by the name of some

Owing to the age of many of these patients, the after-confinement to bed, and the restricted position which lies before them, especial care should be paid to the state of the bowels and kidneys, and any bronchitis, however slight this appears to be, should be treated. The parts having been very widely sterilised, the patient's neck and abdomen are well protected with mackintoshes with warm towels beneath, while sterilised towels are securely packed around the area of the operation, and one wrapped round the patient's hair. Where the patient is weakly, the subject of any bronchitis, the warmth of the trunk and lower limbs should be carefully looked to.* On a cold day the room should have a temperature of 70°. The operation should not be performed on a foggy day. The surgeon should be prepared at every point by the time that the patient is anæsthetised.

It will be well to allude here to a preliminary point of much importance. Let it be supposed that the case is one of doubtful diagnosis, whether one of carcinoma, chronic mastitis, or cyst. While, personally, I hold that when chronic mastitis, which has resisted judicious treatment, is present, the patient being at a carcinomatous age, is rendered much safer by removal of the whole breast (p. 826), and the same is true of many cases of cysts, where this condition does not occur singly, the operator's hands are sometimes tied, and he is pledged to save the bosom if possible. In such cases—and here the patient must take the entire risk—in making any exploration to clear up the case, the surgeon should follow Mr. Watson Cheyne's advice (*Lancet*, 1899, vol. i. p. 757), and make not an incision into the supposed growth, but an excision of it, with a margin of apparently healthy tissue, as the risk of auto-infection is not a mere theoretical danger. If more

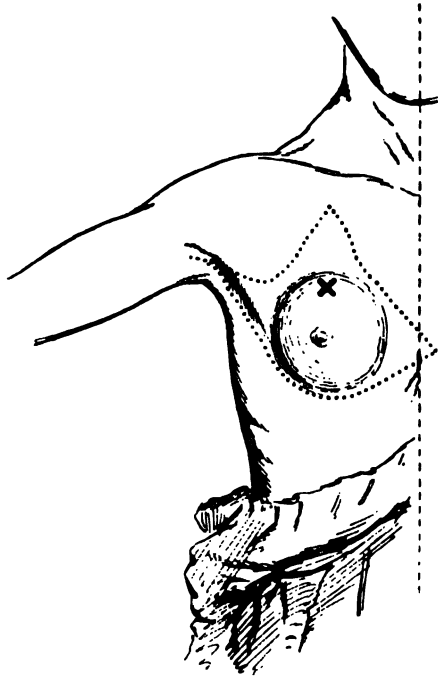
operator—e.g., Dr. Halsted. I have given this surgeon's operation *verbatim* later on. Mr. Watson Cheyne, in the discussion on Mr. Sheild's paper (*Med.-Chir. Soc. Trans.*, Feb. 22, 1898), considered that as Heidenhain and Stiles had described the pathology and mode of spread of breast cancer, and shown in full detail what must be done as regards operation, before Halsted wrote, the operation should be called the Heidenhain-Stiles operation, "after the men to whom the whole credit of it is due." To give to any two operators the whole credit of an operation which, not a new one, has been built up by the labours of many, and which owes its present improved *technique* very largely to the advances of aseptic surgery, appears to me to involve injustice to others. The tendency nowadays to talk and write as if the origin of the modern operative treatment of cancer of the breast dated to the labours of Heidenhain, Stiles, and Halsted, ignores most unfairly the work of others who should not be forgotten. And one name at least—that of an English surgeon—rises pre-eminently as a worker in this field. I refer to the late Sir W. M. Banks. For twenty-three years this surgeon, with unflinching earnestness and characteristic vigour and terseness of expression, in many places urged the need of more extensive operations in this disease. I refer to his papers—"A Plea for the more Free Removal of Cancerous Growths," 1877; "On Free Removal of Mammary Cancer, with Extirpation of the Axillary Glands as a Necessary Accompaniment," 1882; "Extirpation of the Axillary Glands a Necessary Accompaniment of the Removal of the Breast for Cancer," read before the Harveian Society in 1887, a paper which deserved a much more comprehensive title, as in it several points of which we have lately heard so much, viz., removal of the disease in one continuous mass and the need of division of the pectoralis major, are dealt with. These papers are mentioned in the Lettsomian Lectures of Sir W. M. Banks (*Brit. Med. Journ.*, April 7, 1900), and prove that if honour is to be given where it is due a fair share of it must justly fall to him.

* Whenever possible the patient should lie, protected by blankets on hot water, either in a tank as part of the operating table or in a water-bed.

requires to be done the wound is rapidly sutured, and the hands of the operator and any instruments used are resterilised.*

The patient being brought to the edge of the table,† and raised on a pillow to a height convenient to the operator, the arm is sufficiently ‡ abducted to open out the axilla, and fastened or supported in this position. The surgeon then examines the probable extent of the breast § and determines the site of his incisions. It is well not to be tied to any constant rule here. The following will give sufficient choice:—A. The usual elliptical incisions, employed on a very wide scale. B. The same, with angular incisions superadded, as in

FIG. 277.



This and figures 282, 283, 285, 286, illustrate the incisions of Mr. Watson Cheyne. In the first three, angular incisions are shown in addition to the widely elliptical ones. x marks the site of the supposed cancer.

Figs. 277, 282, 283, 285, 286, when the surgeon has to deal with a growth lying near the periphery of the breast. C. The incision adopted by Dr. Halsted (Figs. 291 and 292). D. That employed by Prof. T. C.

* This word reminds me to mention the advice of Mickulicz, that during this and any prolonged operation the surgeon and his chief assistants should be careful to resterilise their hands from time to time.

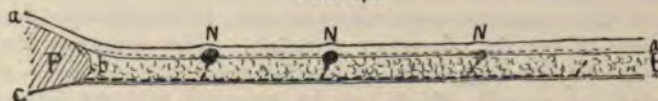
† This step, aided by careful packing of the towels, will diminish the tendency of blood to trickle backwards beneath the patient.

‡ It will be remembered that the more the arm is abducted and elevated the more superficial do the axillary vessels become.

§ Where the bosom is large and pendulous it must be raised before the line of the lower incision is determined upon.

Warren, of Harvard University (Figs. 284, 287, 288, 289), which I consider best adapted to closing the extensive wound usually present, and meeting most efficiently the risk of undermining on the one hand and the need of skin-grafting on the other. E. Before going further with the details of the operation, I will draw attention to a point on

FIG. 278.



To show that subcutaneous nodules do not necessarily imply the extension of growth along the skin.

The above diagram (Handley) represents a section of the parietes at right angles to the surface in the region of the primary growth, P: *a, a*, skin; *b, b*, subcutaneous fat; *c, c*, deep fascia. The subcutaneous nodules, N, N, N, may arise (1) from spread of growth in the skin in the direction of the lightly dotted line, a view generally held, or (2) from spread of growth in the deep fascia, along the heavy interrupted line, with occasional offshoots to the skin, giving rise to subcutaneous nodules. Though this is not the accepted view, it is the correct one in Mr. Handley's opinion.

which Mr. Handley has insisted (*The Centrifugal Spread of Mammary Carcinoma in the Parietes and its Bearing on Operative Treatment*, 1904). As a result of much painstaking work, Mr. Handley concludes that, while mammary carcinoma may spread by the lymphatics of the skin and subcutaneous tissue, it is rather through the deep fascia, guided by lymphatic vessels which may be too small to admit

FIG. 279.



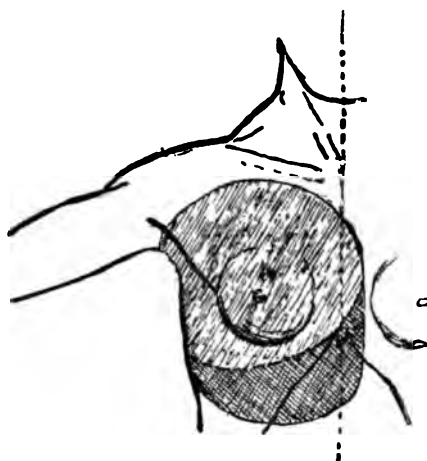
A key-diagram to show the conditions found in a section taken from the upper part of the abdominal wall, demonstrating the invasion of the deep fascia in carcinoma of the breast. The skin at this level was free from obvious growth, though subcutaneous nodules were present higher up. Above is seen the subcutaneous fat, separated from the rectus by A, A, the anterior layer of the sheath. The dark masses, B, are cancer nodules, which originated from growth lying within the vessels of the fascial lymphatic plexus. Here and there they are sending prolongations towards the skin. (Handley.)

carcinoma cells, that the chief advance takes place. Owing to the continuity of the deep fascia, the practical importance of such a conclusion is obvious.

The chief bearing on the operation of the investigations of Mr. Handley, alluded to above, is, in his own words (*loc. supra cit.*, p. 28), as follows:—"The aim should be to remove as widely as is practicable a circular area of deep fascia with its centre at the primary growth,

remembering, however, that growth extends in the fascia more readily in a vertical than in a horizontal direction. The use of the expression 'removal of the pectoral fascia,' instead of 'removal of as wide an area as possible of the deep fascia' and the exclusive attention paid to the axillary glands as the channels of dissemination, have led to the neglect in the excision of the deep fascia over the lower part of the thorax and the upper part of the abdomen. It seems to be in this direction that the scope of the operation requires extension, rather than in the direction of opening up the posterior triangle. The distance from the nipple to the clavicle may be taken as the radius of the circle of deep fascia round the growth which can be removed without difficulty by

FIG. 280.



The lightly shaded area represents the extent of deep fascia removed in the operation of excision of the breast as at present usually performed. The darkly shaded area represents the additional extent of deep fascia which should in future be removed to ensure that the circle of invaded fascia shall be completely circumscribed, and not intersected and partly left behind below. The line surrounding the whole shaded area represents the extent to which the skin-flaps should be undermined. (Handley.)

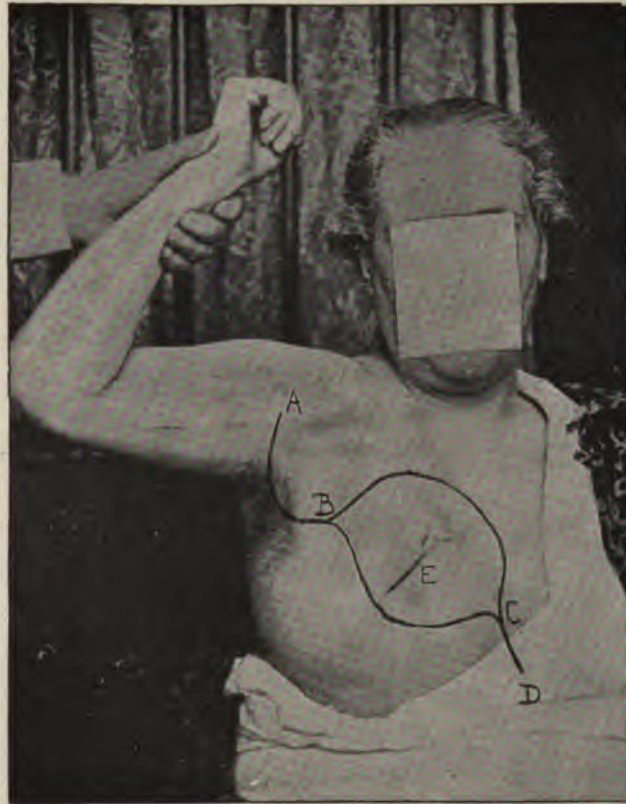
undermining the skin-flaps sufficiently. If the growth starts under the nipple, the deep fascia should accordingly be removed—above, up to the clavicle; internally, one to two inches beyond the middle line; externally, just beyond the anterior edge of the latissimus dorsi; below, to a horizontal line running at least two inches below the tip of the ensiform cartilage. If the growth is in the lower and inner part of the breast, the circle of infected deep fascia will encroach still more on the surface of the abdomen, and over the opposite side of the breast, and removal of the deep fascia in these directions must be carried out yet more widely.

“ . . . In order to obtain access to the upper part of the abdominal wall for the purpose of removing its deep fascia, the lower angle of the incision should be prolonged downwards for two or three inches over the linea alba, and the flaps undermined to a corresponding extent.

Great care should be taken to remove every particle of the origin of the pectoralis major from the rectus sheath. The surface of the latter on both sides of the middle line should be most carefully cleaned, as should also the digitations of the external oblique, down to a horizontal line running two or even three inches below the tip of the ensiform cartilage."

The incisions used by Mr. Handley (*Brit. Med. Journ.*, Oct. 1, 1904) are shown in Fig. 281. An annular one surrounds the breast. A

FIG. 281.



curvilinear one, A B, begins above at the lower edge of the pectoralis major, near its insertion, and ends by joining the annular one also near the lower border of the great pectoral. This incision crosses the base of the axilla and marks out an almost semicircular flap of skin, the convexity of which reaches back almost to the edge of the latissimus dorsi. The linear incision, C D, coming off from the lower part of the annular one, and passing for two inches along the linea alba, allows of the removal of the deep fascia over the upper part of the abdominal wall. The wound should be sutured, if possible, in a triradiate form.

Continuing the details of the operation, I will suppose that the growth is near the centre of the bosom, and that on the right side.

For such a case elliptical incisions, if used on a very free scale, have been considered hitherto. But the above proviso must always be acted upon, and it will be wiser, considering the reliability of Mr. Handley's work, to modify the lower one as he advises. Reappearance of the growth *in situ*, always discreditable to the operator, is usually due to leaving some breast tissue or infected skin behind. To avoid this risk the whole of the skin over the affected breast, however small the growth appear to be, should be removed. To effect this the lower incision (always to be made first) starts from the apex of the axilla below the anterior fold, sinks downwards over the seventh rib in the mid-axillary line, then, passing well below the lower border of the

FIG. 282. (Watson Cheyne.)

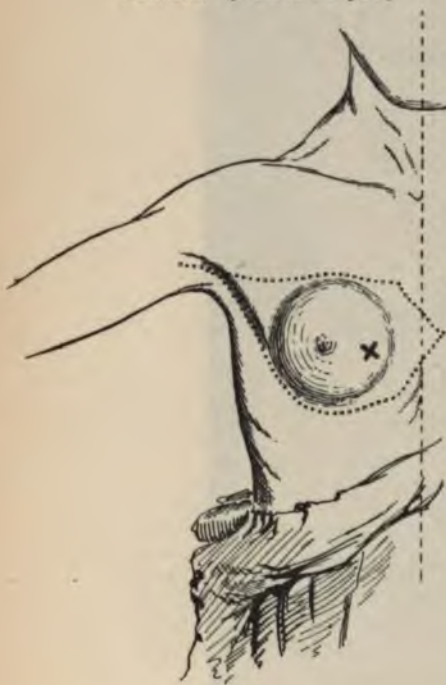


FIG. 283. (Watson Cheyne.)



breast, curves upwards to the sternum. Figs. 280 and 281 show clearly the direction in which the inner part of the lower incision should in future be carried (Handley). An assistant, who stands opposite to the surgeon, now draws up the breast, while the surgeon, taking the cut margin between his left finger and thumb, dissects downwards an extensive flap. In doing this he must take just sufficient fat to maintain the vascularity of his flap. If he take more than this, lobules of breast tissue, possibly infected, are very likely taken also, these being difficult to distinguish from their surrounding fat as soon as blood begins to flow. If less be taken, sloughing of the fat, and very likely a condition of sapræmia, is extremely likely to follow. In making either of the elliptical (or any other) incisions the knife should not pass down to the muscles at once. A considerable area of

fat and fascia is to be left (Figs. 284 and 288), to be removed at the next step, in order to make sure of removing the whole bosom, the description of which according to the text-books as always definitely encapsuled is not reliable (p. 824). As the flaps, elliptical or other, are raised, Spencer Wells's forceps are applied to every bleeding point. The bosom being next drawn down, the upper elliptical incision is

FIG. 284.



Division of the pectoralis minor. Note here and in Fig. 288 the care taken to leave a large circumferential zone well wide of the disease. The anterior edge of the latissimus dorsi is shown here and in Fig. 287, denoting the limit of the dissection outwards. (Warren.)

made between the extremities of the first, passing above the upper limit of the breast. An upper flap is raised in the same way as the lower one, and dissected up to within about an inch of the clavicle. Bleeding vessels are here also quickly secured with forceps, and as

each batch accumulates they should be tied off with fine sterilised silk. If it be objected that incisions made on such wide lines will prevent primary closure of the wound, the answer is, that only by operating on such lines is extirpation of the disease to be hoped for, and reappearance, especially its worst form *in situ*,* to be prevented, and therefore primary closure of the wound is scarcely to be considered at this stage. It will be shown by details given later (p. 845) to what a large extent primary closure may be secured even in these hugely gaping wounds.

The surgeon next lifts the breast away from the chest wall, and proceeds to detach the widely outlying zone of fat (Figs. 284 and 287), working from the sternum to the axilla, and from below upwards. This is effected either with a scalpel or, as I prefer, with blunt-pointed scissors. The parts being rendered tense by lifting up the breast, every atom of fat and fascia in the above-mentioned zone is removed. As this is done the top of the external oblique and the serratus magnus below and the latissimus dorsi externally are uncovered. The lower border of the pectoralis major is soon reached. The costo-sternal part of this is now removed by cutting through the muscle† just outside the sternum and along the ribs, detaching it with the breast from without inwards, then defining the interval between the clavicular and costo-sternal portions, and finally severing the muscle close to its humeral attachment. The question of thus removing the costo-sternal part of the pectoralis major has been already discussed at p. 826. If the operator remove only that part of the pectoral which lies under the breast, he has excellent authorities behind him. But he must make certain that he does remove all such part of the pectoral. As pointed out at p. 825, Volkmann has shown that a deep plexus of lymphatics lies in this fascia, and that it is never safe to leave this structure, as it is quite impossible to tell with the unaided eye whether it is involved or no. Any attempt to remove the fascia from the muscle is to be condemned as certain to leave some of the fascia behind; while from the oozing which attends any such attempt more blood is lost than when the muscle is itself removed.

The whole mass—breast with overlying skin, the widely surrounding zone of fat and superficial fat and fascia (Figs. 284 and 287), and the pectoralis major—is now raised, if the breast be a large one, by an assistant, the mass being wrapped in gauze, so that both the surgeon's hands are free for the delicate work which comes next. The mass is manipulated by the surgeon, or an assistant with the twofold object of keeping it out of the surgeon's way and also of putting on the stretch the different structures which have yet to be removed. All along it should be remembered how essential it is to get the disease away in one continuous mass. The cut clavicular part of the pectoralis major is next raised with a broad-clawed retractor, and the loose tissue beneath it carefully dissected from the muscle. "This tissue is rich in lymphatics, and is sometimes infiltrated with cancer" (Halsted). The mass of breast, &c., being carried outwards, the fatty tissue is

* Because now the recurrence is constantly visible to and dwelt on by the patient.

† In severing and detaching the pectoralis major, care must be taken not to injure the costal cartilages, or tedious exfoliation may follow.

stripped from the thoracic wall, close to the ribs, down to the pectoralis minor. This muscle is then divided and removed at its origin and insertion, so as to make certain of getting away the very delicate fatty tissue on it and beneath it, which, as Dr. Halsted has pointed out, is rich in lymphatics and often cancerous. Any surgeon in doubt as to the removal of the lesser pectoral muscle will have referred to the remarks at p. 827. The first part of the axillary and the termination of the subclavian vein is now exposed at the highest possible point (Fig. 287), and the sheath and overlying fatty tissue are carefully removed from the axillary vein in its whole length, and

FIG. 285. (Watson Cheyne.)

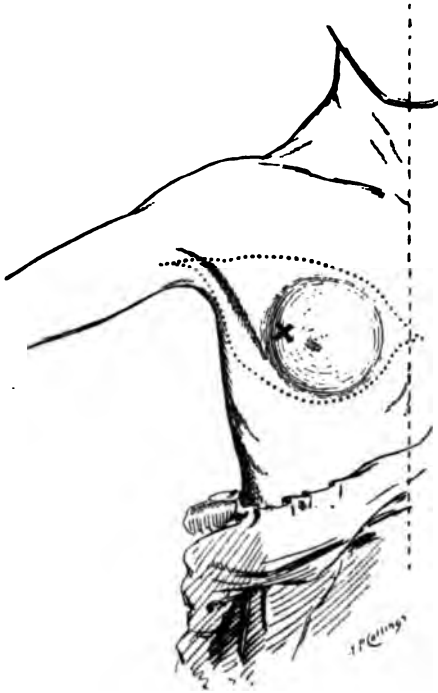
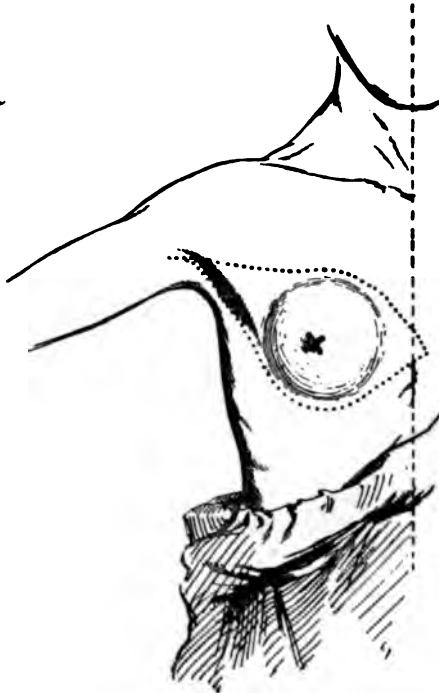


FIG. 286. (Watson Cheyne.)



with these the fat and glands in the axilla, according to the directions given below. Dr. Halsted's cautions at this stage should be remembered.

The numerous small veins which will be met with now should be carefully tied, owing to their delicacy, close to the axillary vein, and "no particle of extraneous tissue should be included in the ligature" of these and other vessels. On no account is the operator to pull out the glands and fat from the axilla with his fingers—a step certain to leave infected tissues behind. The need of getting away the disease in one continuous whole is now especially to be remembered. In cleaning the sheath a scalpel should be employed, but for the rest I prefer blunt-pointed, slightly curved scissors, which serve not only for cutting but for separating structures.

Great care is needed in cleaning the fatty tissue, and especially so,

if enlarged glands are present, from the axillary vein. If this trunk be injured a purse-string stitch taking up the opening is very difficult to apply; leaving on a pair of Spencer Wells's forceps is not reliable; and ligature of the vein below and above the opening will probably be required. This is spoken of by some operators as a slight matter, and

FIG. 287.



The division of the pectorals permits the retraction downwards and inwards of the breast and axillary contents and enables the operator to expose freely the axilla, and to tie the main branches at their origin. (Warren.) It will be noticed that Prof. Warren removes the breast from without inwards. The advantages claimed are that the operation is shortened and the hæmorrhage lessened by dividing the vessels at their origin at the beginning of the deep dissection, while the greater part of the wound is not exposed until the close of the operation. Further, a free dissection of the axilla is permitted up to the point of disappearance of the axillary lymphatics beneath the clavicle before the mass to be removed has been dislodged from its attachments and allowed to interfere with the anatomical relations of the parts.

as one which will not cause after-trouble. In two cases in which, to get away adherent glands, I was compelled to remove a portion of the axillary vein between two ligatures, the resulting œdema and trouble were much less than I expected; in one case they could scarcely be said to occur at all. But this result is not to be relied upon. It probably depends on the level at which the *venæ comites* of the brachial join the basilic (a somewhat variable point), and the relation of this to the part tied. As there is a most distinct risk of a heavy œdematous arm resulting, the only excuse for resecting part of the vein is when an enlarged gland is adherent to it and breaks down in the attempt to remove it.* Whether it is needful to expose and clean the artery is doubtful; Dr. Halsted (*vide infra*) thinks it safer to do so. It prolongs the operation considerably. Mr. Watson Cheyne practises a careful step at this stage which is noteworthy. When the vein has been cleaned and the axilla cleared out there still remain some lymphatics which run up behind the vessels towards the posterior triangle. These may be infected. To remove them "the vessels and nerves must be lifted up, and this mass of fat and glands lying in the triangular space between the vessels in front, the scapula outside, and the chest wall inside should be taken away."

The axillary vessels having been defined and cleaned, the surgeon will now be more at ease in stripping out the contents of the axilla from its inner and posterior walls. The fatty fascia which ties the mass of breast, &c., to these regions is further put on the stretch and dissected off from the serratus magnus and intercostals. As to the intercosto-humeral nerve, it is not worth while to dissect it out and preserve it. The lateral branches of the intercostal vessels need careful cleaning and securing, especially below at the juncture of the internal and posterior wall, where, in the thickest part of the serratus magnus, there is always an anastomosis between the above-mentioned vessels and the subscapular artery. This anastomosis will certainly be cut into if the fat and fascia over the serratus magnus have been efficiently removed. Unless these bleeding points are promptly secured, much blood will be lost, and a collection of blood may easily take place here, and cause trouble afterwards.† As the posterior wall is cleaned the subscapular vessels and nerves will come into view. It is very easy, by using undue force or haste in stripping clean the subscapular or other veins, to tear one or more of these away close to the parent trunk, sometimes leaving a small hole punched out in this vessel. In such cases the hæmorrhage is most embarrassing, and must be met either by taking up the aperture with a purse-string suture of fine sterilised silk, or ligaturing the vein above and below—a point alluded to above.‡ If

* For the treatment of that rare complication, injury of the axillary vessels, the section on injury to the femoral vessels should be referred to.

† Such a collection, leading to tension on the flaps, will require draining. Again, from the proximity of the axilla, which with its regrowing hairs it is not always easy to keep sterile, any fluid here may become infected.

‡ The remarks made above on injury to the vein apply, of course, with increased significance, to the artery. Mr. Sheild says that he has seen similar trouble to that described above occur by cutting arterial branches when pulled on, close to the main trunk. He has twice seen lives in great peril from the step that was found needful, viz., ligature of the main trunk above and below the opening.

there be time, if the patient's condition be favourable, and if the fat strip easily away, the subscapular nerves, especially the long one, should always be spared. Under other conditions no time should be spent in dissecting them out. As will be seen below (p. 853), Dr. Halsted is not yet decided on this point. Mr. Butlin (*Operative Surgery of Malignant Disease*, p. 397) writes: "I have not attempted to spare the subscapular nerves, and I have been surprised to find that the movement of the upper extremity is remarkably good, provided too large an area of integument has not been taken away." For my own part, I consider that loss of power in the latissimus dorsi should not weigh for a moment against any step that favours complete removal of the disease; that if primary closure of the axilla and primary union of the axillary end of the wound be secured—conditions which are always possible—and the precaution given below as to the position of the limb and early movement be followed, a very useful arm and shoulder-joint will result. Fig. 294 shows how much elevation and abduction may be gained three weeks after the operation, even where both pectorals have been removed on each side, if the after-treatment is attended to.

The posterior wall of the axilla having been now cleaned to a point on a level with the latissimus dorsi, all that remains is to sever the mass of breast, &c., along the line of its connection with the outer border of this muscle.

The operator now scrutinises the wound to see what scraps and tags of fatty tissue may remain in dangerous positions—*e.g.*, over the subscapularis, or along the vessels, or in the apex of the axilla. In spite of the greatest care to get the diseased structures away in one piece, such shreds of tissue may be left. At this stage the huge wound, which has been kept carefully covered, wherever possible, with dry sterilised gauze, should show a floor consisting, from within outwards, of muscle—*e.g.*, above, clavicular part of pectoralis major; a little lower, a narrow rim of costo-sternal portion of the same muscle, external intercostals, upper part of external oblique, attachments of pectoralis minor, serratus magnus, subscapularis, teres major, and latissimus dorsi in part. Bleeding is next finally attended to. Throughout the operation, in order to diminish the shock inseparable from these extensive and prolonged proceedings, great care must be taken to secure every bleeding point, and to tie off the forceps before they accumulate, instead of trusting to their being moved out of the operator's way as required, a course which often leads to their becoming entangled with each other. But at this stage there is another reason for rendering the wound as dry and bloodless as possible. Primary union depends largely on absence of any after-oozing and tension on the sutures, which are very likely to be themselves taxed to the utmost. Two difficulties arise here. One, that, owing to a depressed state of the circulation, vessels may not bleed though unsecured. The administration of a little ether, if safe on other grounds, or gentle friction of the wound, as advised by Mr. Sheild, may be of assistance here. If these fail, and the operator is rendered anxious by the unnatural absence of bleeding, he should insert a drainage-tube (p. 845) and apply his bandages with additional firmness. The other difficulty is of a different kind. The perforating branches of the internal mammary, when they are cut short and retract, may give much trouble. I have been able to

meet this either by the use of Spencer Wells's forceps curved on the flat, and ligature, or by pressure. But the following case of Mr. Sheild's (*Diseases of the Breast*, p. 402) shows how embarrassing this difficulty may be, and how it may be successfully met. Met it must be, otherwise the persistent bleeding will lead to tension and separation of the flaps.

"A perforating vessel, the size of a small quill, was cut or torn, flush with the thin structures in the fourth interspace, about two inches from the sternum. It retracted and bled profusely and persistently. All methods of securing it failed, and a fine curved needle threaded with silk was dipped into the tissues around, but all to no purpose. A hare-lip pin was passed through the lower flap, and a small piece of sponge the size of a walnut was threaded upon it, and then the pin was passed through the other flap, a figure-of-eight silk suture being applied. All bleeding was arrested. The pin was removed on the third day, and the sponge on the fourth. The case did well."

Mr. Sheild (*loc. supra cit.*, p. 403) also alludes to another and much rarer difficulty, that of calcareous arteries, which persistently broke off when the ligatures were tightened. This was successfully met by leaving on pressure-forceps for twenty-four hours.

Two questions now arise. If the operator is, before closing his wound, inclined to *irrigation*, I strongly advise him to use only boiled water. If proper aseptic precautions have been taken throughout, irrigation is not required. Certainly, with so large a surface exposed, no kind of chemical solution should be employed, except, perhaps, where an infective condition has been present, such as an ulcerating carcinoma (p. 822); and the same reasoning applies to the use of iodoform.

The question of *drainage* next presents itself. Where the axilla and the cavity of the wound are very deep, where any oozing continues—and sometimes, owing to the condition of the patient, the operator is hurried at this stage,—where the flaps are loaded with coarse unhealthy fat, and, if I may add without offence, in his earlier operations, the operator will do well to use a large india-rubber tube, sterilised by efficient boiling, with one end projecting from the axillary end of the wound, and the other brought out posteriorly by a counter-puncture.

It remains to close the wound. Three courses are open here. (i.) A method which will suffice in a large proportion of cases, even where the wound measures upwards of eleven inches in length by seven or eight in breadth, if elliptical incisions have been employed, is that of *undermining*, and the use of *stout silver wire*. The bases of the flaps must be first freely undermined in every direction, upwards almost to the clavicle, inwards over the sternum, downwards over the external oblique and lateral thoracic wall. Care must be taken to cut the flaps as thick as possible and with even incisions of uniform depth, the blade being used on the flat. Three or four sutures of stout silver wire* are then passed through the flaps a full inch from their edges.† To the ends of the wires Spencer Wells's forceps are clamped, and the flaps then slowly and steadily

* Silver wire is necessary. Stout silk, however efficiently boiled, cannot be relied upon to remain sterile if points of stitch-necrosis take place.

† Before these are inserted the surgeon carefully adjusts and regulates the line along which the flaps will be approximated, bringing the lower one from without inwards. Tension will be felt least at the axillary and most at the sternal end of the wound.

approximated. To effect this the wire *must* be stout, it must have an efficient hold on the flaps, and these, owing to the resulting tension, must be slowly and deliberately dragged together. Large needles will be required. No special apparatus, such as leaden buttons, is necessary.

FIG. 288.



Preliminary dissection of the integuments in all directions, leaving a pyramidal mass of tissues to be removed of which the primary nodule is the apex. The outer lateral flap is also shown. (Warren.)

The flaps need not meet exactly, as the next step will accomplish this. Numerous (twenty or more) stout salmon-gut sutures are next introduced, clamped, and tied off in batches, the surgeon working at one end, and an assistant at the other. While this is being done, another assistant with sterilised pads renders the wound dry by careful pressure on the flaps. By the very numerous salmon-gut sutures the tension is evenly

distributed over a long line. Not unfrequently it will be found possible, when all the sutures are tied, to cut those of silver, thus relieving the chief tension. Dossils of sterilised gauze are now wrapped round the silver wire to prevent their ends pricking the patient. Large sterilised

FIG. 289.



A. The flap has been turned in and caught with one suture. It is gradually being pushed into position by peripheral sutures. B shows how the upper half of the outer edge of the wound is slid under the lower half. Note the shortening of the long axis of the wound by the stitching on the lower border. (Warren.)

ads, and over these salicylic wool, are next kept in position by even bandaging; the object being to distribute the oozing as uniformly as possible, and to meet its tendency to come through at three spots—viz., the lower border of the dressings, at the sternal end of the wound, and behind the axilla.

It is well, before the elbow is shut in, to dust a little sterilised boracic acid powder over the fold in front, especially when the patient is one inclined to intertrigo, and when the weather is hot, owing to the irritation of the perspiration thus retained.

(ii.) To enable the surgeon and patient to dispense with the necessity of skin-grafting, usually a second operation, Prof. Warren (*loc. supra cit.*) has adopted the method shown in his excellent illustrations (Figs. 284, 287, 288, and 289). I made use of it towards the close of my active surgical life, and recommend it strongly.

In addition to the free racket-shaped incision, "a flap should be marked out on the outer side of the pectoral region (Figs. 284 and 288). To do this, the knife divides the skin above the middle of the first incision, *i.e.*, on the outer edge of the wound, on a line drawn at first at right angles to the said incision and gradually sweeping round until it becomes parallel to it and terminates at a point a little above the level of the lower margin of the wound. This flap is intended to be turned into the lower portion of the wound. . . . This flap is about the size of the hand, and when first turned in seems to be totally inadequate for the purpose. A few stitches should be taken at the axillary and sternal ends of the wound first. The flap is then turned in (Fig. 289), and held in place by a temporary stitch, while it is gradually pushed up into place from below by sutures firmly 'girding' together the edges of the skin to which the flap was originally attached. Thus it gradually comes about that the point B, which was originally in contact with point A, is rolled in underneath the flap, and forces it into position. Sutures should all be superficial, as deep sutures cut and do not give the skin included by them a chance to stretch. In order to enable the edges to come together easily, it should not be forgotten that it is necessary to dissect up the skin for a considerable distance in every direction. In stout patients the cavity of the wound is easily closed, but the problem is more difficult in thin individuals. Experience only will enable the operator to determine how much tension can be put upon the flap in inserting the final stitches. In doubtful cases there is no objection to leaving them untied, as the opening thus left serves admirably for drainage." The wounds should be dressed at the end of twenty-four hours, and any gauze drainage then removed.

(iii.) *Skin-grafting by Thiersch's Method*, p. 233.—While this may be employed at the time of the operation in a wound which cannot be completely closed, it is best to defer it to a date between the eighth and fourteenth day. Though this involves a second anæsthetic, the patient will be in a much better condition; the surface of the wound will be smaller, and a level, uniform one, and there will be no oozing. Prof. Warren's method will largely replace that of skin-grafting.

(iv.) *Transplantation of Skin Flaps*.—

Mr. Butlin and Mr. Adams, at a meeting of the Medico-Chirurgical Society April, 1896, recommended this step in cases where primary closure of the wound could not be otherwise attained. The method of transplantation by rotation was recommended. The flaps should have large bases, and should not be more than three and a half or four inches long. To this method there is one objection, and one of much weight. The patients, after an extensive operation such as that of to-day for removal of the breast, are not in a condition to stand the additional time and anæsthetic required for the careful making and transplantation of flaps. Where primary closure of the wound cannot be attained by undermining and dragging the flaps together, it will be wiser to resort to skin-grafting.

After-treatment.—The patient should be kept on the sound side for the first few hours after the operation, as this promotes the escape of any vomit well away from the dressings, while it also helps to prevent any collection of fluid at the axillary end, where the chief cavity has been made. Afterwards the patient should be kept, supported, up in the bed as much as possible, to prevent that tendency to stasis and broncho-pneumonia which is so close at hand in the subjects of chronic bronchitis, obesity, &c. If possible, after the fourth day the patient

FIG. 290.



To illustrate the results of Thiersch's grafting. The patient—one of Dr. Scott's, of Ealing—was under my care in March, 1900. The photograph was taken ten days after the grafting. On the arms are the scars left by the grafts.

should be lifted into an arm-chair and spend an hour or two out of bed daily. These patients are not only kept too long in bed, but the arm is usually kept closely to the side too long. For the first few hours, to check any oozing, and to meet any restlessness after the anæsthetic, the arm and forearm must be kept securely quiet. But after this the arm should be gently and easily abducted by a large pad of salicylic wool in the axilla. A little later the patient, while in bed, should be encouraged to keep the limb away from her side with the forearm extended, while at night a sling should again be resorted to. The degree of abduction should be gently increased day by day, while by night the limb may be now kept abducted, but steadied by a splint. In about ten or fourteen

days more active outward and upward movements should be practised. While after-limitation of movement is partly unavoidable owing to the necessary free removal of skin, &c., much of the after-stiffness will be prevented if care be taken at the time of the operation to secure primary closure of the axillary end of the wound without much tension, and if, later on, both surgeon and patient will dispense with the too usual rigid bandaging of the arm to the side, and be more persistent in practising early movements.

With regard to the dressing of the wound, the first dressings will probably require to be additionally packed, especially behind, during the first forty-eight hours. And the patient, whatever position she take, should always lie on thick gauze pads during the first three or four days, lest any discharge come through, especially when she is left undisturbed to sleep, and reach the sheets. If drainage has been employed the wound should be dressed at the end of twenty-four or thirty-six hours, the drainage removed, any over-tight sutures cut, and the dressings left undisturbed for another three or four days. If no drainage has been employed, the need of dressing will generally turn upon the tension of the sutures. As the skin, owing to its elasticity, has great accommodating power, it will generally be found, if the tension has been distributed over a large number of sutures, that no stitch-necrosis, or very little, takes place. In my experience it is well to change the first dressings early, even if the temperature be normal. Such a step adds much to the comfort of the patient, and allows of the division of any sutures which are already causing, or are about to cause, slight ulceration. With regard to these, it is not necessary to disturb the edges of the wound by removing the sutures. Judicious cutting of those on which the tension is too great is all that is required at first. Further, too many must not be divided at this early date, or there will be gaping of the wound in the second week. Another advantage which I consider gained by not allowing the dressings to remain unchanged too long during the first ten days is that an opportunity is secured of cleansing the axilla. This step is rendered advisable by the difficulty of sterilising a region like this at the time of the operation, and the growth of hair which has taken place.

Halsted's Method.—Out of respect to Prof. Halsted and the excellent work which he has done in many directions at the Johns Hopkins University, Baltimore, I here quote, in his own words, the account of his mode of removal of the breast (*Ann. of Surgery*, Nov. 1894):

"(1) The skin incisions are carried at once and everywhere through the fat. (2) The triangular flap of skin (Fig. 291) is reflected to its base. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major, where it is continuous with the fat of the axilla. (3) The costal insertions of the pectoralis major (M, Fig. 292) are severed, and the splitting of the muscle, usually between its clavicular and costal portions, is begun and continued to a point about opposite to the scalenus tubercle on the clavicle.* (4) At this point the clavicular portion of the pectoralis major and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla. (5) The loose tissue under

* (?) First rib.

clavicular portion (the portion usually left behind) of the pectoralis major is carefully dissected from this muscle as the latter is drawn upwards by a broad, sharp retractor. This tissue is rich in lymphatics,

FIG. 291.

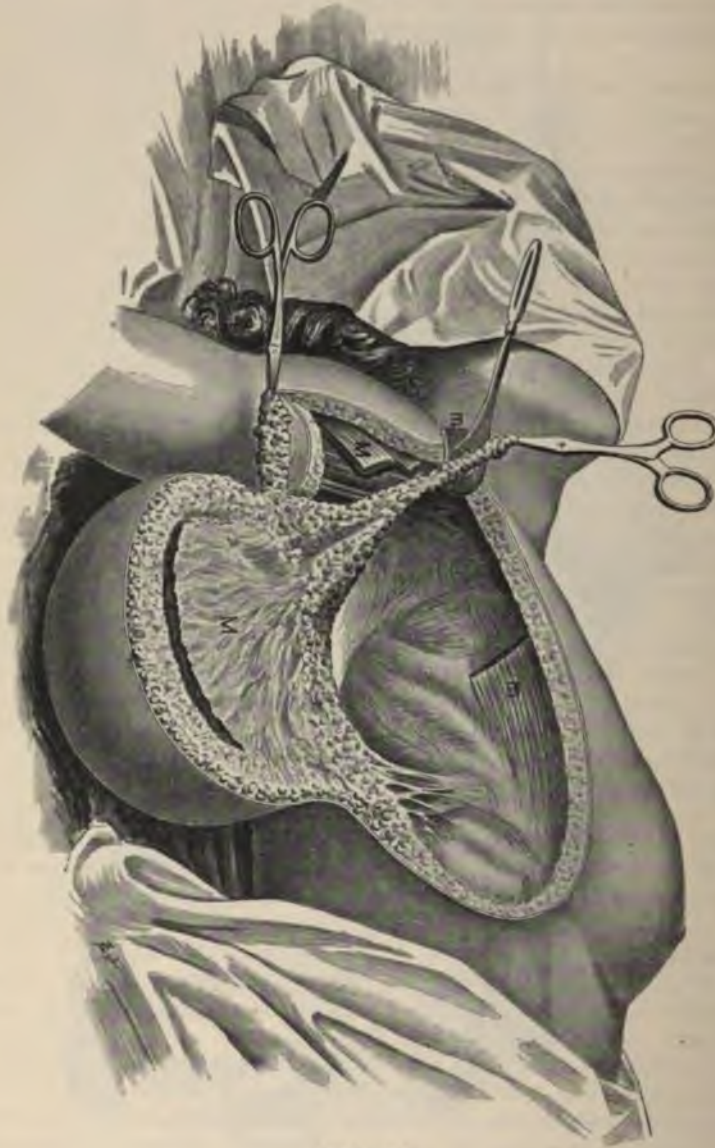


(Halsted.)

and is sometimes infiltrated with cancer. (6) The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is close to its humeral attachment. (7) The

whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin incision, is raised up with some force, to put the sub-muscular fascia on the stretch as it is stripped from the thorax close to

FIG. 292.



(Halsted.)

the ribs and pectoralis minor. It is well to include the actual sheath of the minor muscle when practicable. (8) The lower outer border of the minor muscle having been passed and clearly exposed, this muscle is divided at right angles to its fibres, and a little below its middle.

(9) The tissue, more or less rich in lymphatics, and often cancerous over the minor muscle near its coracoid insertion, is divided as far out as possible, and then reflected inwardly to liberate or prepare for the reflection upwards of this part of the minor. (10) The upper outer portion of the minor is drawn upwards (Fig. 292) with a broad, sharp retractor. This liberates the retractor, which until now has been holding back the clavicular portion of the pectoralis major. (11) The small blood-vessels (chiefly veins) under the minor muscle near its insertion must be separated from the muscle with the greatest care. These are embedded in loose connective tissue which seems to be rich in lymphatics, and contains more or less fat. This fat is often infiltrated with cancer. These blood-vessels should be dissected out very clean, and immediately ligated close to the axillary vein. The ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off, or the vessels themselves might be torn away by the clamps. Furthermore, the clamps, so many of them, if left on the veins, would be in the way of the operator. (12) Having exposed the subclavian vein at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers, as advised, I am sorry to say, in modern text-books, and as practised very often by operators. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed, it is best to push the vein away from the tissues rather than, holding the vein, to push the tissues away from it. It may not always be necessary to expose the artery, but I think that it is well to do this. For sometimes, not usually, the tissues above the large vessels are infiltrated, and we should not trust our eyes and fingers to decide this point. It is best to err on the safe side and to remove in all cases the loose tissue above the vessels and above the axillary plexus of nerves. (13) Having cleansed the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla. We must grasp the mass to be removed firmly with the left hand, and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus. (14) When we have reached the junction of the posterior and lateral walls of the axilla, an assistant takes hold of the triangular flap of skin and draws it outwards to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi. The operator, having taken a different hold of the tumour, cleans, from within outward, the posterior wall of the axilla. Proceeding in this way, we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed, at the discretion of the operator. Küster lays great stress upon the importance of these nerves for the subsequent usefulness of the arm; we have not as yet decided this point to our entire satisfaction, but think they may be often spared to the patient with safety.

(15) Having passed these nerves, the operator has only to turn the mass back in its normal position, and to sever its connection with the body of the patient by a stroke of the knife. All that has been removed is in one piece (Figs. 292 and 293). There are no small pieces or shreds of tissue. I believe that we should never cut through cancerous tissues when operating, if it is possible to avoid doing so. The wound might become infected with cancer, either by the knife which has passed through diseased tissue, and perhaps causing everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli, or from the lymphatics. The division of one lymphatic vessel and the liberation of one cell may be enough to start a new cancer. . . . The operation, as we perform it, is literally an almost

FIG. 293.



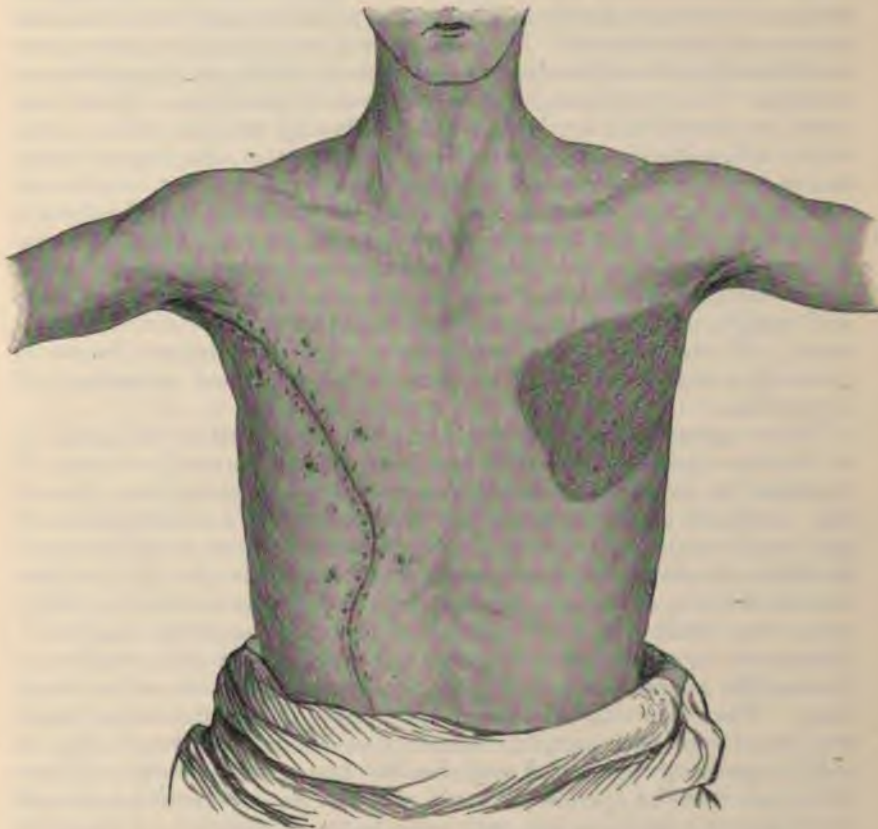
This shows the continuous whole or single piece, breast, axillary fat and glands, of which the part removed should consist. (Halsted.)

bloodless one. From the first to the last each bleeding point is stopped with an artery-forceps as quickly as possible. When practicable, the vessels are clamped before they are divided. . . . The edges of the wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin, only the base is included in this suture. The rest of this flap is used as a lining for the fornix of the axilla. The apex of this flap is consequently shifted to a new and lower position. The axilla is never drained, and invariably heals by first intention. The uncovered wound often heals by the so-called organisation of the blood-clot."

C. Long-continued supervision repeated at first at short intervals.—The patient should be kept under skilled supervision, and for the first few years an inspection of the scar should be made every three or four months. Any localised and superficial reappearance in or near the scar should at once be attacked widely and deeply (p. 857); operations,

where the disease is fixed, involving resection of one or more ribs, if needful, as in the cases to which I have alluded at p. 872, are very rarely to be advised.

FIG. 294.



E. S., æt. 54. The left breast had been removed at another London hospital in February, 1899, the pectoralis major being left entire. Recurrence took place in the scar towards the end of the same year. Patient came under my care at Guy's Hospital with a scirrhus of the right breast, the existence of which had been known for three months. Both sides were operated upon, simultaneously by myself and Mr. C. T. Hilton, on December 10, 1900, both pectorals being removed on each side. On the right side I found it possible, by extensive undermining, to drag the flaps together, the three larger dots on each side showing where the stout silver wire used had caused slight tissue-necrosis. On the left side the above step was impossible. The photograph was taken on January 3, 1901, and Thiersch's grafting was resorted to, on the left side, on January 4. The amount of elevation which can be regained in three weeks after a double operation is also shown.

There are still a few points of much importance to be discussed before the subject of removal of the breast for cancer can be said to have been dealt with. I refer to such points as—(i.) *The removal of*

both breasts. (ii.) *The value of palliative operations.* (iii.) *Operations for reappearance of the disease.* (iv.) *The advisability of performing such operations as amputation at the shoulder-joint, or Berger's amputation.* (v.) *Oöphorectomy for inoperable carcinoma of the breast.*

(i.) *Removal of both Breasts.*—It occasionally, though rarely, happens that, as in the case shown in Fig. 294, a patient comes for advice with cancer of both breasts. By some operation at this stage has been condemned on two grounds—viz., its certain futility and its additional severity. In my opinion, no such rule can be laid down. Each case must be considered by itself. The following are the chief points which will guide in a decision. First and foremost, the surgeon must decide whether the growth is a primary one on both sides, or whether on one side it is secondary to the other. In the latter case the disease is so widespread that operation is not to be recommended. In the former, if there be no evidence of visceral or secondary deposits (beyond any in the axillæ), operation may be recommended if the patient's age and vitality be favourable. And here age is a point of much importance. If the patient be young, the presence of bilateral disease is probably a sign of the mischief being widespread, and operation will be useless.

When operation has been decided upon, the question will arise as to whether the breasts should be removed simultaneously or no. If possible, the two breasts should be removed at one operation. And as the operation of the present day is so extensive and requires such prolonged care, it will be best if the operation is done simultaneously by different operators. Such a step much diminishes the risk and also the discomforts of the patient, especially that of the anæsthetic, while, where the vitality is good, the shock is not dangerously increased. Extra care in nursing will diminish the additional trouble entailed by the needful restraint of both arms. But no fixed rule can be laid down here. Where the vitality is poor, where there is any bronchitis, where the breasts are large and the wounds necessarily extensive, it may be well to postpone the second operation for two or three weeks. Where it is clear that the operation on one side will be so extensive as to call for Thiersch's grafting, this may indicate the advisability of removing the breasts by two operations.

(ii.) *The Value of Palliative Operations.*—Patients occasionally come to the surgeon asking for operation under conditions which make it certain that any benefit given by surgical interference will be only temporary. The following may be among the reasons that arise for consideration: (a) Relief from pain, which otherwise increases daily; the misery of waking every day to the consciousness of an incurable disease; the sometimes loathsomeness; the restlessness for cure (Paget). (b) Death by deposits in the viscera, these being unseen, is less distressing to the patient than death by the original disease in the breast, which is always under her eyes. (c) The patient may have special reasons for wishing to live and get about in comparative comfort for a year or so.

Thus, in a case mentioned by Sir B. Brodie (*Lect. on Path. and Surg.*, p. 202), he declined at first to operate on a lady with a scirrhous of the breast on the point of ulcerating. In a few weeks the patient returned, begging to have the breast removed,

that, her life being rendered more comfortable and active, she might accompany in society an only daughter. The operation was successfully performed, and at the end of two years the patient died of secondary pleuritic effusion.

No general rule can be laid down here. Each case must be decided on its own merits. But the following cautions may not be superfluous. Especial care should be taken in these cases to exclude, as far as possible, the presence of metastatic deposits. If these are certainly present no operation should be performed. The patient's general condition and vitality must be sufficiently good. There must be grounds for honestly supposing that the local disease which it is proposed to attack will be got away; otherwise the latter condition of the patient may be rendered worse than the first. Again, in these palliative operations it should be clearly explained to the patient and her friends that the operation will only be palliative. Some patients, and especially the friends of some patients, are only too ready, when it becomes evident that no cure is possible, to forget the plain and honest warning that was given, and to place the entire responsibility on the surgeon. And this leads up to one more point. In these palliative operations, and in all doubtful operations for cancer, it is not only the individual patient that has to be considered: the thoughtful surgeon will remember the effect of his operation on many other potential patients. Thus, a palliative operation or an extensive operation under conditions doubtful of success is performed, both sides of the question having been honestly put before the patient. The operation is not permanently successful, as was fully explained might be the case. The want of permanent success becomes known to a circle of varying extent. We do not sufficiently consider what effect this want of success has on other patients also sufferers from cancer of the bosom, but quite ignorant of the conditions in which the operation referred to was performed, in leading them to conceal their cancer, at the time eminently suited to operation, until the most favourable opportunity has passed away.

(iii.) *Operations in the Case of Reappearance of the Disease.*—A very poor prospect of success is offered here, chiefly because the disease proves to be far more extensive than appears to be the case. This is especially true of recurrence in the axilla. Such conditions as extensive infiltration of the skin, either by shotty nodules or by the evidence of *peau d'orange*;* infiltration of the glands in the neck, evidence of visceral deposits, implication of the axillary vessels and nerves, prohibit operation absolutely. In my opinion, the only conditions which justify hopefulness in dealing with local reappearance are (1) small local nodules in the scar or the axilla, or (2) infected areas of larger extent occurring in cases where the operation performed has been a limited one, and not on the wide lines which have been recommended above. And the chief points which guide me are the degree of mobility and the size of the reappearing mass. But even where these and other points appear favourable, the real extent of the disease, the facts that the operation has now to be performed in scar tissue and not in loose fat, and that the anatomical landmarks are much altered, militate greatly against success. Local reappearance

* Much to be preferred to our coarse English expression, "pig-skin."

after the improved operations of to-day is much rarer, but it does occur, and the fact that in these cases the preceding operation has been on wide lines shows, I think, that here the disease from the first has had an extensive hold on the patient. I will conclude with one or two hints. If the recurrence, though local, is deeply seated in the tissues of the scar, necessarily scanty after removal of the pectorals, I believe the only operation likely to be useful is partial resection of the ribs, as in the cases alluded to at p. 872. If the recurrence is in the axilla the exploratory incision should be of the freest, as these are just the cases where the axillary vein may be easily opened.

Finally, we must all allow that the only real treatment for reappearance of the disease is preventive. It is only by operating, *on the first occasion*, on the widest possible lines, and in the most thorough manner, that we can really meet recurrent disease. In Mr. Watson Cheyne's weighty words, "the patient's chance lies in the first operation."

(iv.) *Removal of the Entire Upper Extremity or Amputation at the Shoulder-joint for Recurrent Inoperable Carcinoma.*—These operations have been occasionally performed with the object of giving relief to the agonising pain and heavy, œdematous, swollen, immobile state of the limb which sometimes is seen to follow implication of the axillary vessels and nerves. Any hope of cure, even by the most extensive of these operations, is quite out of the question. Decided relief will be given, but it will not be unmixed relief. Some twenty years ago I amputated at the shoulder-joint in a case of this kind. Great relief to the pain was given, but it was clear to me that during the five months which preceded the patient's death the loss of one hand was constantly present to her. If any such operation be performed, it should be on the lines of those of Berger (vol. i. p. 177), and not an amputation at the shoulder-joint, in which the incisions may pass dangerously near to the disease. Mr. Dent brought such a case before the Medico-Chirurgical Society (*Brit. Med. Journ.*, March 12, 1898).

Here the left breast had been removed in a woman æt. 53, together with the affected axillary glands, in December, 1894. In September, 1896, a recurrent nodule was removed from near the scar. In October, 1897, the patient was readmitted with a recurrent ulcerating growth high up in the axilla. The arm was much swollen and the pain severe. On October 22, 1897, the upper extremity, scapula, and outer two-thirds of the clavicle were removed by M. Berger's method, with a few modifications.* The hæmorrhage did not exceed two or three ounces, and there was no shock. All the diseased parts appeared to have been removed. The patient made a rapid recovery, and great relief followed the operation. But in March, 1898, there was evidence of secondary deposits in the liver, and the patient died on April 10, 1898.

This operation is, in my opinion, scarcely to be recommended. It is palliative only, and the relief it gives is temporary and obtained only at great cost. It certainly should not be suggested till a trial has been made of the *x*-rays (p. 860). Cases causing agonising pain from involvement of the brachial plexus are extremely rare.† Swollen, heavy, œdematous limbs are more common, though also rare. In such cases relief can almost always be given by elevation of the limb at night, aided by careful bandaging or a well-fitting support always worn. Very rarely, owing to the patient's neglect, this condition of œdema has gone so far that recurrent attacks of erysipelas or sloughing are present.

* Of these the chief was cutting the anterior flap smaller than usual, owing to the involvement of the skin in the axilla.

† Sir W. M. Banks gave one successful case (*Clinical Notes*, p. 59). By dissecting the subclavian triangle and peeling off several enlarged glands from the nerve trunks, relief was given to the previous intolerable pain. Mr. Sheild (*Diseases of the Breast*, p. 419) has had an equally successful case. But, as a rule, the nerve trunks are in these cases too much embedded in the deposits to admit of any such "peeling."

Amputation by Berger's method would now be justifiable, but both sides of the case must be clearly put before the patient. And, before performing such an operation, I should advise exploration to see if it were possible to remove the disease sufficiently from the axillary vessels and nerves to allow of the remainder of life being relieved from pain at a less cost than loss of one hand. Division of the brachial plexus high up in the neck, which Mr. Dent suggests might be considered in some of these cases, would, I fear, have to be carried so far as to render the limb useless. Mr. Dent is of opinion that the following would be favourable *indications* for the above operation:—(1) Previous removal of the breast, with dissection of all the lymphatic tissue and fascia off the pectoralis major, a step which lessens the likelihood of mediastinal infection. (2) Slow growth of the original tumour. (3) Slow growth of the reappearing disease. (4) Limitation of the growth, so that the incisions may be carried wide of the disease. (5) The certainty of relieving pain. "Unless the pain were severe, indeed the predominant symptom, the operation would hardly be taken into serious consideration." (6) The existence of a foul carcinomatous ulcer high up in the axilla. Mr. Dent gives the following as *contraindications*:—(1) The probability of leaving in the wound the cut surface of any part of the carcinoma, as leading to rapid increase and fungation of the growth. (2) The involvement of the thoracic wall. (3) The presence of an extensive degree of carcinoma *en cuirasse*. (4) The more obvious contraindications of deposits elsewhere.

Mr. Stanley Boyd, whose energy and skilfulness are well known, has also advocated high amputation in these cases (*Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1167). Two instances are given. In one amputation was performed below the tuberosities of the humerus in January, 1900. The patient could get about afterwards and do some work till three weeks before her death. Finally the stump ulcerated, death taking place in July, 1900. In the other case, amputation was performed at the shoulder-joint in January, 1900. After this the patient got about more easily. In April, 1900, she died.

(v.) *Oöphorectomy in Inoperable Carcinoma of the Breast*.*—The life of this operation, as of several others in late years, appears to me likely to be a brief one. The cases are, I think, sufficiently numerous to justify the following conclusions. While the operation has in a certain number of instances produced a decidedly beneficial result, these cases have not been numerous; and in every such case the benefit has been temporary only. Thus Mr. Stanley Boyd, who has taken up the matter with much interest, in his paper (*Brit. Med. Journ.*, 1900, vol. ii. p. 1161) has collected 54 cases and divided them into two groups—(a) those in which oöphorectomy seemed to produce a clear and decided effect, such as shrinking and disappearance, sometimes rapid and even temporarily complete, of all the reappearing growths in the skin and glands, with disappearance of pain and swelling; (b) those in which oöphorectomy had little or no effect. Of the 54 cases thus classified, Mr. Boyd finds that 19 (35 per cent.) were more or less markedly benefited, 34 were not benefited or only doubtfully so, and one died of exhaustion. As to the duration of the improvement, when present, Mr. Boyd considers that, as far as the cases as yet available for drawing conclusions go, in the majority the growths reappear or begin again to increase in six to twelve months. It is interesting to note "that, with one exception, all the patients who had certainly passed the menopause are included among the failures." And it must be remembered that this operation is one of those novelties in practice in which we are likely to hear of successes chiefly.† When we remember that

* Whatever be the fate of this operation, the credit of suggesting a trial of it, in May, 1896, must always be given to Dr. Beatson, of Glasgow. Speaking in a discussion on "The Treatment of Inoperable Cancer" (*Brit. Med. Journ.*, Oct. 25, 1902), Dr. Beatson, while he maintained that there were certain cases in which oöphorectomy was of service in prolonging life and lessening suffering, stated that he had never claimed for it any curative power.

† In Mr. Stanley Boyd's paper allusion is made to several unsuccessful cases, of which he was unable to give the full notes. Mr. Bowreman Jessett (*Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1191) states that he has tried oöphorectomy with the administration of thyroid extract in four or five cases of inoperable mammary cancer, but with any improvement. In April, 1900, a woman was sent to me for anything further could be done for recurrent carcinoma of the

oöphorectomy is not to be relied upon for checking the hæmorrhage and growth of uterine carcinoma, it is probable that little is to be expected from this operation here. And it must be remembered that, whatever temporary benefits the operation may confer, it is liable to produce certain unpleasant effects of its own. Finally, it is to be noted that, in two cases referred to by Mr. Boyd, oöphorectomy for inoperable carcinoma of the breast has been fatal, in one case from "exhaustion," in the other from "intestinal matting." While I consider that the benefits of oöphorectomy for inoperable carcinoma of the breast are too uncertain, and, when they do occur, of too brief duration to justify the operation, to those who may think differently I would urge—(1) that they explain the matter fully and honestly to their patient and her friends, and leave the decision in their hands; (2) if the operation be performed, every atom of ovarian tissue must be removed. As pointed out by Mr. Doran, the ovarian ligament is sometimes very short, and may contain ovarian tissue close to its uterine insertion.

With regard to the relative influence of oöphorectomy and of thyroid extract in producing the atrophy which sometimes occurs, opinions differ. Thus Mr. Boyd (*loc. supra cit.*) writes: "When endeavouring to ascertain the result of one mode of treatment based upon highly theoretical considerations, it is surely unwise to combine it with another method resting on still more shadowy grounds. I have consequently never given thyroid until satisfied that the oöphorectomy was failing in its effect. Then I have given it, but without obvious benefit; on the contrary, it has sometimes seemed to have a damaging effect." On the other hand, Dr. Herman ("Four Cases of Recurrent Mammary Cancer treated by Oöphorectomy and Thyroid Extract," *Brit. Med. Journ.*, Oct. 20, 1900, p. 1167) observed that Mr. Boyd's table comprised 17 cases in which oöphorectomy seemed to have favourably influenced the course of cancer. Of these 12 had been given thyroid extract. There were 21 in which no benefit had followed, and only 5 of these had had thyroid. This looked as if the thyroid extract had something to do with the result.

X-ray Treatment of Malignant Disease: some Conclusions.—While the number of cases which have been reported with sufficient accuracy and, still more, after a sufficient interval has elapsed are too few to enable us to draw many reliable conclusions, we have sufficient knowledge before us to be certain that, with further experience in properly selected cases, greater results will be achieved.

(A) *Carcinoma*.—To take the case of persistent carcinoma mammæ first, as the one in which this method will be chiefly employed:—Relief from pain is a prominent feature. Hæmorrhages and discharge are decidedly lessened, and, in a certain proportion, ultimately cease. Dermatitis is, within certain limits, a desirable feature of *x-ray* treatment (Grubbe, *Med. Rec.*, Nov. 1, 1902). Even in the hopeless cases the *x-ray* treatment prolongs life, makes the patient more comfortable, and the last hours more free from pain. The treatment is most likely to fail in cases where the patient is young, the persistence large in amount and active in its progress, and on the other hand, when much dense fibrous tissue is present. The method may be harmful (*a*) by stimulating the rate of growth, perhaps by the employment of too weak treatment, (*β*) by too rapid destruction of large areas and flooding the system with toxins (Leonard, *Philadelphia Med. Journ.*, Feb. 14, 1903).

My readers will be glad to have the following opinion from Mr. Gould on the above, as he writes (September, 1905) with the authority of an established authority: "I quite agree with what you have said, but I should add one or two further points

been removed without any benefit. The patient in question as to the result of the oöphorectomy, said, by day as I lay in bed after the removal of the ovaries

mammæ is very often arrested, foul ulcers become clean, and in many instances the ulcers heal up. Growth is held in check, or partially, or in some cases wholly, disappears. I have seen many examples of each of these three results; *e.g.*, I have seen an extensive absolutely fixed growth in the breast become so much loosened and free from the chest walls, that it became a suitable case for excision, and the operation was satisfactorily accomplished.

(B) "Epithelioma of tongue and mouth in my experience is not benefited, and I have only once or twice seen marked good in the secondary epitheliomatous growths in cervical glands. In one case of a large, deep ulcer threatening to open into the deep vessels of the neck, rapid healing occurred under the rays, and the patient died from another effect of the disease, broncho-pneumonia. In another case glandular growths have been held in check, and have very distinctly lessened in size; but, as a rule, the treatment is very disappointing in these cases,

"I have seen two or three very striking results in carcinoma recti. In one, a large fungating recurrence after excision entirely disappeared, and the man is leading an active life and in good general health. In another, a doctor, who was laid aside from practice entirely for six months, got rid of his *locum tenens* and resumed all his work in a busy practice.

"We have had two cases of those big cedematous arms from secondary supraclavicular growth in which the change has been so great that cedema has disappeared, and the women have resumed work."

Thomas's Method of Removal of Innocent Mammary Tumours.—As fibro-adenomata are far from uncommon, and as any scar on the breast is much deprecated by young women, this operation, which Dr. Gaillard Thomas, of New York, introduced in 1882, may be made use of when a patient especially deprecates a scar on the bosom itself. An incision is made exactly following the groove between the skin of the lower half of the breast and that of the chest. On reaching the muscles, the breast is dissected from them sufficiently to allow of its being turned upwards so as to expose its posterior aspect. A straight cut is then made through this over the tumour, and the latter removed. The gland is then replaced. Aseptic precautions must be employed and adequate drainage provided. The scar is invisible save when a free incision has to be made—*e.g.*, for a fibro-adenoma high up in the breast; the ends of it then show.

Owing to the excellent results and very trivial ultimate disfigurement which the ordinary method of removing fibro-adenomata affords, that of Dr. Thomas will very rarely be called for. Further, as Mr. Sheild writes (*Diseases of the Breast*, p. 213): "While excellent in theory, this operation is not always easy in practice, and its adoption will a good deal depend upon the position and mobility of the tumour. I have performed the operation on two occasions. The first was simple, since the tumour was easily reached from below. In the second case the growth was unexpectedly adherent, and I experienced great difficulty in its removal and also in the checking of hæmorrhage. Both cases did well, and the resulting scar was hardly visible. The difficulties of the second case, however, would deter me from again performing the operation unless in a very accessible and movable tumour."

CHAPTER II.

PARACENTESIS AND INCISION OF THE CHEST. RESECTION OF RIBS.

PARACENTESIS AND INCISION OF THE CHEST.

INDICATIONS for interference in pleuritic effusions. Before interfering operatively, the surgeon has two points to consider: I. Whether fluid is present. II. Whether it is purulent or not. Space will only allow of my dealing with the second of these points.

II. Is the fluid purulent or not. If pus is present it is very rarely absorbed; it may burst into the lung, may burrow about, making its way externally, causing hectic, caries, and lardaceous disease.

A. Exploratory puncture. A large hypodermic syringe and needle should be used, absolutely sterile, pervious, and the needle sufficiently long and not too flexible. The timely use of this may save much delay. A grooved needle should never be trusted to. It is readily plugged by a pellet of fat, and thick pus will not flow along it.

B. Presence of pyrexia and hectic. This is not always reliable. Fallacies: (a) They may be absent, or little marked, in empyema, especially in long-standing cases, the alteration of the pleura or the degree of tension preventing absorption. Occasionally the disease is latent for many months. (b) Well-marked pyrexia may be present in serous effusions.

C. The aspect of the patient. The tint is often anæmic and earthy in long-standing empyema, and the finger-ends, especially in children, clubbed. "If a child be seen with general pallor and finger-clubbing, one ought to think of empyema rather than of the other causes of clubbing—viz., chronic bone disease, bronchiectasis, and congenital heart disease" (Barlow).

D. Age. Empyema is common in children and young adults.

E. Rigors. These are often slight, irregular, and may occur only towards evening. In children they are often absent throughout.

F. Any preceding disease. Empyema is not unfrequently seen after pneumonia, scarlet fever, measles, childbirth, pyæmia, small-pox, and especially typhoid fever. The onset is most insidious and often overlooked. If a patient during convalescence seems to go back, loses his appetite, any embarrassment of the breathing must be at once looked for, and empyema suspected.

G. Oedema. This is often absent, though pus is present.

H. Other signs, especially in children, must be remembered—viz., unexplained and obstinate diarrhoea, emaciation, &c.

Treatment of Non-purulent Serous Effusions.—Question of operation. If medical treatment—*e.g.*, absorbents and diuretics, counter-irritation, dry nutritious diet, &c.—fail, two questions arise: (A) *What is the danger of leaving the fluid?* (B) *What is the risk of paracentesis?*

(A) *Danger of leaving the fluid.*

1. There is the risk of sudden death when a large, quiet effusion persists.*

Dr. Moxon showed that the effect of the effusion varied with the side affected. Thus an effusion into the right chest not only pushes the heart over to the left, but also compresses the right auricle, and so shuts off blood from the heart, thus tending to produce syncope from cardiac anæmia. Effusion on this side also tends to make lateral pressure on the inferior vena cava, which is the more readily bent over as it has just passed through a rigid ring. Effusion into the left chest drives the heart over to the right, and, pressing on the left auricle, distends the right side of the heart, by impeding the passage of the blood into the left ventricle, and thus tends to bring about syncope from cardiac plethora. There is also a tendency for the right lung to become œdematous, owing to its being engorged with blood.

2. The lung may become more and more tied down by adhesions—*e.g.*, when much lymph has formed.

3. The sound lung may become engorged, especially if the patient is submitted to a chill.

4. There is the risk of slow pus-formation, especially in a patient much let down, where the effusion is secondary to some other disease, and where there is the history of a chill.

(B) *The risks of paracentesis.*

1. Shock. This is especially probable in delicate patients with a nervous dread of the operation. 2. Syncope. A special cause of this is perhaps alteration of the position of the heart and large vessels by removal of the supporting fluid. 3. Embolism from detachment of clots in the pulmonary veins. That this is a real risk is shown by a case of Sir B. Foster's in which clots dislodged from the right pulmonary veins caused embolism of both renal and iliac arteries, with a fatal result from albuminuria, suppression of urine, and gangrene. Both 2 and 3 may perhaps be prevented by not drawing off all the fluid, and drawing it off slowly. 4. Œdema of the lung. This is an undoubted danger. Shortly after the tapping (the effusion being usually a large one), urgent dyspnoea comes on with frothy, serous expectoration rich in albumen. Death usually takes place in about twenty-four hours. Dr. Duffin's explanation of this is probably the correct one. The compressed lung, after the removal of a large effusion, corresponds to a limb after the use of Esmarch's bandage—*i.e.*, the vaso-motor nerves are paralysed: thus, when the lung expands, sudden stress is thrown on toneless vessels; hence the transudation of sero-albuminous fluid, equivalent to the oozing so common after removal of the bandage.

Indications for Paracentesis in Non-purulent Effusions.

1. Threatened failure of the heart's action, shown by the failing

* I think it is Dr. Clifford Allbutt who records the case of a girl who had been brought Addenbrooke's Hospital with a large, quiet, serous effusion. Having got out of the which had brought her, she was walking slowly across the green in front of the when, without a cry or a stagger, she was seen to fall dead.

pulse, the extremities growing cold, &c. 2. In all cases, and at any date, when the fluid is so copious as to compress the opposite lung. The base of this should be carefully watched, and any expectoration noted. 3. In all cases where, with a large effusion, there have been one or more attacks of orthopnoea. Relief will be most emphatically called for when, with this history, the patient lives some distance off, when he is no longer young and the chest no longer yielding, or when the opposite lung is at all cedematous. 4. In all cases in which a pleuritic effusion, occupying half one pleural cavity, has existed three or four weeks, and shows no sign of progressive absorption.

Paracentesis for Serous Effusions.—The site of puncture. This is decided by—(1) Physical signs. (2) The result of the exploring needle. Common sites are—(a) The sixth space in front of the posterior axillary fold, a spot which has the advantage of being thinly covered, and where the ribs are well apart. (b) In the seventh, eighth, and ninth space behind, in the scapular line. The eighth space is here very frequently used.

The patient having been turned somewhat over on to his sound side, if he can bear this, and brought to the edge of the bed, or, if he must be raised, so supported that he can be readily lowered in case of faintness, the surgeon, having seen that the spot chosen for puncture is sterilised, and that his aspirator is thoroughly clean and in good working order, fixes his nail just above the lower rib, and, holding the needle so that it cannot penetrate too deeply, plunges it straight into the pleural cavity, and then brings it into connection with the vacuum. If the skin is very thick, and the needle slender, it is well just to make a puncture with a scalpel's point. In either case it is the skin wound which pains.

The following practical points should be remembered: (1) Not to catch the needle on a rib, a mistake which is easy when the ribs are close together. (2) To be sure and enter the chest cavity, a thickened pleura or false membranes sometimes interfering with this. (3) To avoid injury to the lung, by not plunging the needle in too deeply, or by guarding the point when it has entered. Usually the lung is at a considerable distance, but when the collection is a localised one this accident may easily take place. (4) The fluid should not be drawn off too quickly or completely; if successive vacua are required, the later exhaustions should not be too complete. The patient should always be warned against making any sudden movement or a deep inspiration. If the flow stops suddenly, it may be due to a kink in the tube, or to a pellet of lymph plugging the needle. The flow should always be stopped at once—(a) if the patient faints, this being due sometimes merely to the withdrawal of a large amount of fluid, sometimes to the consequent displacement of viscera; (b) if any blood suddenly appears in the fluid, this coming usually from the rupture of vascular adhesions, more rarely from a wound of the lung; (c) if an irritating cough is set up, this being due sometimes to the unfolding of a temporarily compressed lung.

When the needle is withdrawn, the puncture should be at once closed with collodion and iodoform.

On the question of anæsthesia or local analgesia the remarks at

pp. 652, 868, should be referred to. As a rule, the pain is so momentary that these are not needful.

Incision of the Chest for Serous Effusions.—This is indicated in certain cases of long-standing effusion where paracentesis has been performed more than once, and has on each occasion been followed by rapid recollection of the fluid. Several successful cases have been recorded, two striking ones described by Dr. Samuel West (*Brit. Med. Journ.*, 1898, vol. i. p. 494), in which the fluid had been present for twelve and fifteen months respectively. The first case was quite cured; the second patient at the date of publication still had a sinus, but was otherwise in good health and able to earn his living. A warning is needed here—as to the great risk of a sinus following and thus infection, especially where the chronic effusion is tuberculous, an incision being here a very risky step. Mr. Godlee (*Diseases of the Chest*, with Dr. Fowler, p. 596) is emphatic upon this point: "The surgeon is often asked to open these, especially if the fluid has become slightly turbid. My experience is that if this be done, the fatal conclusion is hastened. Such patients are able to get along very well with a very considerable collection of fluid in the chest; but when a free opening is made, they become much more short of breath, and, as the discharge is copious for a long time, it is very likely that septic organisms will be allowed to enter. This is the beginning of the end. I have in a few tubercular cases which were, so to speak, halfway between serous effusions and empyemata, given considerable relief by inserting two cannulæ, one, in front, made to communicate by a tube with a large bottle of sterilised boric lotion, the other, far back, being put in communication with the syphon or bottle aspirator. The fluid was slowly exhausted, and its place taken by the boric lotion. As soon as the latter flowed quite clear into the bottle, the anterior cannula was removed, and as much as possible was exhausted from the chest. This appears sometimes to diminish very considerably the rapidity of the reaccumulation. Possibly other fluids, such as tincture of iodine and water, might prove more efficacious."

EMPYEMA.

The frequency of this in children* has been already alluded to.

At this time of life the prognosis is good, as the lungs are more likely to be free from morbid changes. The formation of pus may be very rapid at this early stage of life, pus being present by the fourth, fifth, or seventh day. The importance of this is considerable. Thus—(a) the pleura is soon altered, thickened, and less prone to heal; (b) the lung becomes tied down; (c) the drainage tube is readily blocked; (d) subdivisions may form in the cavity, and so thorough drainage and obliteration are rendered difficult.

Another important point is, that pus in the pleural cavity is frequently localised and encysted in children. This is not uncommon in the middle third of the thorax, the pus being limited above by

* Out of forty-four and sixteen consecutive cases of pleuritic effusion at Great Ormond Street, Sir T. Barlow found twenty-seven and fourteen to be purulent.

adhesions, and below by the fixing of the lower lobe to the chest wall.* Thus, at this spot loud bronchial breathing and modified resonance may be present. Finally, in children small multiple collections are not uncommon.

The surgeon will very likely be asked the question whether the pus need be withdrawn, and if it will not be gradually absorbed. The chances of this are extremely small, and the risks of leaving it very great. They are—(a) external perforation, leading to the unfavourable results of insufficient drainage, caries, and amyloid disease. The most likely sites are—in front, above, and below the nipple; antero-laterally, in the fifth space, just outside the rib cartilages. (b) Lung perforation, leading to gangrene and hectic. (c) Tuberculosis, an old empyema, even if caseated and inspissated, being infective. (d) The empyema may also burst into the œsophagus or pericardium. In other cases it has been known to track downwards behind the diaphragm and give rise to a lumbar, gluteal, or even a psoas abscess. In such cases pulsation of the swelling has been observed, synchronous either with respiration or with the heart-beat.

Treatment of Empyema.

A. Simple Puncture with Aspirator or Fine Trocar.—This is seldom curative. The cannula will entirely fail to remove the flocculent or fibrinous masses which are often present, and the existence of which we have no means of foretelling (p. 867). Aspiration will certainly need repetition; this is a fertile source of the need of resection of ribs later. Aspiration is only justifiable in a few conditions—(a) in bilateral empyemata; (b) if the patient is very young or very timid; (c) if the collection is very small or multiple; (d) in advanced phthisis or pyæmia; (e) as a temporary or palliative measure in malignant disease, or in old and feeble patients. Patients thus treated should be watched for some time. In a few cases preliminary aspiration is to be strongly recommended, namely, in large empyemata of the left side where the heart is displaced. By aspiration, twenty-four or forty-eight hours before the chest is opened, the danger of syncope (which may be fatal), arising from sudden displacement of viscera, may thus be averted.

B. Sub-aqueous Drainage.—This method, formerly much in use, is now rarely seen. One end of a long piece of india-rubber tubing is introduced through a large cannula into the chest, while the other end dips into some antiseptic solution. *Advantages:* (1) The method is simple and little painful. (2) The tube is usually well tolerated, and, if secured, follows the movements of the patient. (3) The drainage can be made gradual and adapted to the expansion of the lung. (4) It is readily converted into a syphon for washing out the chest. I look upon this last as of very doubtful advantage, believing that, if the pus is fœtid, a free opening should be made at once, and that washing out the chest is always risky, and meddlesome, and uncalled for when the pus is sweet. The *disadvantages* are—(1) The tube, necessarily small, is easily blocked. (2) Ulceration soon takes place around the tube, and thus air enters, or the tube slips out. It is allowable in children, or in very nervous patients, where the collection is neither great nor of long standing, and the lung will therefore be able to expand gradually.

* While the commonest form of localised empyema is that lying between the lung and costal pleura, two others may be met with: that between the diaphragm and the lung, and the variety situated between two lobes or between the lung and mediastinum.

C. Incision.—This, with very few exceptions, is the best method. Its chief advantages are the free drainage which it gives and the facilities for washing out the pleural cavity if this is required, (*vide infra*). Although the method of simple incision has met with considerable success, yet in most cases, nowadays, a piece of rib is resected as well.

The chief *advantages* of this are as follows:—(1) Perfectly free drainage is provided for, since the largest sized drainage-tube can be used, and there is no longer the fear of compression of the tube by closely placed ribs. (2) The aperture is large enough to allow the surgeon to thoroughly explore the cavity with his finger. Its extent and the characters of its walls may thus be gauged, and further valuable information at times obtained—*e.g.*, a case of pyæmia under Sir W. Savory, in which a distended pericardium was felt through an opening in the left pleura. This was opened through the same wound, and twenty-four ounces of pus evacuated (*Path. Soc. Trans.*, 1884). (3) The large masses of fibrinous lymph so often found lining the cavity can be easily removed by the finger and a scoop, and prolonged discharge perhaps thereby prevented. Where such masses are present the empyema is very frequently due to the pneumococcus, and especially requires early and complete evacuation. Such empyemata are common in children, and while sometimes of a mild type, are always liable to cause serious complications, *e.g.*, pericarditis or, more remotely, peritonitis and arthritis. It is the large masses mentioned above which especially call for a free opening and removal of a rib, for if retained they not only prevent complete evacuation, but are sources from which further invasion by the cocci or their toxins may take place.

The *disadvantages* are, that the operation is more prolonged, and also somewhat more difficult, than simple incision.

There are practically no disadvantages as regards the effect on the rib itself, for new bone formation is generally quite rapid enough, and caries and necrosis are almost unknown. Removal of a piece of rib is then to be recommended, except where the necessary appliances are not to hand, or the condition of the patient forbids any but the shortest possible operation.

The question will occasionally arise whether a single or a double opening is required. A *single opening* is usually sufficient in children and in young adults, especially where the history is a recent one. The sites usually chosen are the seventh, eighth, or ninth space in the posterior axillary line, or in the same spaces just outside the line of the angle of the scapula. In adults the chief part of the opening should be anterior to the latissimus dorsi, an incision through a well developed muscle having certainly the risk of causing oozing afterwards, which may be very serious in a weakly patient. Hutton (*Brit. Med. Journ.*, vol. ii. 1898, p. 1321) recommends incision over the sixth rib in the mid-axillary line, because (1) this is the last point to which the lung expands; and (2) it is more comfortable to the patient. A *double opening* is very occasionally required—*e.g.*, in very large cavities in adults when the pus is fetid; when the case is of very long standing; when the pus is pointing high up and anteriorly, and thus the drainage is inadequate. The best instrument to cut upon in making the counter-operation is a stout silver probe. To this a drainage-tube can be attached by silk, and easily drawn into place.

The chief points of importance in the operation are the following: Amongst the first will arise the question of giving an anæsthetic. Speaking from an experience of over forty cases, I believe that an anæsthetic may be safely given in the vast majority of cases. On the whole I think that chloroform is the most suitable, on account of the greater struggling (undesirable with viscera displaced), the dyspnœa set up by the mucus, and the bronchitis subsequent to the administration of ether; but I am certain that the way in which the anæsthetic is given is of more importance than the anæsthetic itself.

I have only known bad results follow the anæsthetic twice—both adults, one a case of large empyema with pyopneumothorax. The heart was displaced to the right side, the face and lips somewhat cyanotic, the extremities cold, and the pulse almost imperceptible. Although the dangers of an anæsthetic were put before him, the patient insisted on having one administered. On the whole, I thought ether the safest, because of the condition of the pulse. It was administered carefully, but caused coughing. The pus was thus sucked into a bronchus, up into the trachea, and thence drawn down to the opposite lung, causing death rapidly. Artificial respiration expelled, during expiration, pus from the trachea. As this patient was almost moribund before the operation, I now much regret the giving of an anæsthetic. It would doubtless have been wiser to have refused one, and to have trusted to a preliminary aspiration, or to minimising the shock by exhibiting a stimulant and by a rapid operation; the case occurred before the days of local analgesia. The other fatal instance was also in a patient in a grave condition, a lady aged 38, very stout and flabby. Chloroform was administered by very skilled hands, and death occurred from syncope. I have operated in three other cases of empyema with pneumothorax successfully; chloroform was employed in each case.

Local analgesia (p. 652) should certainly be used where a general anæsthetic is thought inadvisable. Mr. G. L. Chiene (*Scot. Med. and Surg. Journ.*, September, 1904, p. 215) used the following mixture: four parts of 2½ per cent. eucaine β; one part of 1 to 1,000 of adrenalin chloride. Thirty minims of the above solution were injected into the subcutaneous tissue over the line of the long axis of the rib. Twelve minutes were allowed to elapse, and then the usual operation performed; this was accomplished painlessly, more of the solution being applied to the periosteum before the rib was excised. The tissues in the region of the injection became blanched; there was practically no bleeding, no pain even when the bone was cut through, and no after-hæmorrhage.

When no rib is removed the operation is performed as follows:—

The patient being supported over the edge of the bed or table, partly rolled over on to the sound side, or, if this is impracticable, suitably propped up, the surgeon, having cleansed the part, fixes a finger-nail just on the upper margin of the lower rib in the space chosen (p. 867), and makes an incision down to the muscles for one and a half to two inches, just above his nail. In every case the presence of pus at the spot chosen should first be verified with an exploring needle. This incision having exposed the muscles, a steel director is driven through

into the chest cavity, care being taken not to plunge it too deeply.* A pair of dressing-forceps is then run along the director and opened widely both horizontally and vertically. Owing to the gush of pus which is now violently expelled, it is well to throw a sterilised piece of gauze over the wound, while the pus is escaping.† This prevents any entrance of air, and regulates an otherwise perhaps too rapid exit of fluid. The opening is next thoroughly dilated by means of a pair of lithotomy-forceps or sequester-forceps, the jaws of which are carefully separated, and the size of the cavity, the proximity of the lung, and the degree of granulation formation all investigated.

When, as will usually be the case, a portion of a rib is to be removed, the steps of the operation are slightly different. The incision is made directly over the rib and straight down to bone, the periosteum being divided. The periosteum is now stripped off the rib for a distance of about one inch and a half with a slightly curved raspator, care being taken to thoroughly clear the pleural surface. The rib is then divided in front and behind. This can in most cases be accomplished with a strong bone-forceps, but if the ribs are large and dense it may be necessary to first cut a groove with a saw.

The piece of rib is now removed, and the cavity opened with director and dressing-forceps, as above described, care being taken to push in the director exactly over the upper border of the rib, in order to avoid the intercostal vessels. Having in this way made a free opening, and the pus having been evacuated, any large flakes of lymph may be removed by the surgeon's finger or a blunt-edged scoop, and a drainage-tube inserted. This should be of large size, and just sufficiently long to reach the cavity without projecting into it. Any coiling of the tube in the cavity is useless, and may be harmful. The inner end of the tube should carry one large lateral opening. An ordinary tube should be securely fixed in position by means of safety-pins, in order to prevent it from slipping into the pleural cavity. Another method easily provided is to slit the outer end of the tube into four strips and attach each of these by silver wire to a small square of india-rubber sheeting. Mr. Bilton Pollard's tube (Fig. 295) is very simple and efficient. One of the methods given should always be adopted to prevent the tube slipping into the pleural cavity.

Hutton (*loc. supra cit.*) has recently described a drainage-tube fitted with a duck-bill valve, which, while allowing the exit of pus during expiration, prevents the entrance of

* If the chest is being opened low down, and the above warning not remembered, the director, or the dressing-forceps which follows it, may easily be sent into the peritoneal cavity.

† Occasionally, if the patient struggles, air is drawn into the pleural cavity after the escape of the pus, and then is expelled into the connective tissue of the wound, constituting emphysema. This will all pass off spontaneously. I have met with a case of much more marked emphysema under the following conditions: Having been asked by my colleague, Dr. Pitt, to incise the chest of a child who, after lobar pneumonia of the right lung, had rapidly developed empyema on the same side, I noticed that, after an incision at the angle of the scapula, the usual violent outgush of pus, itself free from blood, was immediately followed by frothy blood and a markedly emphysematous condition of the wound. I believe that here the lung tissue, damaged by previous inflammation, had given way when the pressure of the fluid upon it was removed. A few days later it was evident that the lung had become adherent around the incision, which communicated freely with an opening in it, and that the emphysema had subsided. The case did well.

air during inspiration, thus promoting a more rapid expansion of the lung. The advantages claimed are :—

- (1) That it hastens materially the expansion of the lung.
- (2) That it is simple, inexpensive, and comfortable.
- (3) That by hastening the expansion of the lung it will obviate, in many cases, the necessity of Estlander's operation, which means the deprivation of the use of one lung.
- (4) It is devoid of risk, as it only aids nature, by enabling the lung to keep the advantage it has gained by each expiratory effort.

Judging from the above points, and from the satisfactory results which Mr. Hutton describes, this apparatus is worthy of more extended trial.

Hæmorrhage during the operation is usually slight, and gives no anxiety afterwards. If any point give trouble, resisting ligature, after picking up the tissues with Spencer Wells's forceps, a pair of these left on for twelve hours will meet the case; a bit of a rib quickly resected will give access to a wounded intercostal artery.

The opening must be sufficient, and, if there is any doubt about this, a further portion of rib should be resected without hesitation, especially where these are very close together, or where the pus is foul (*vide infra*), or contains large flocculent masses.

If the question of washing out the cavity arise, probably from the discharge being foul, it should be remembered that this proceeding, however gently done, has occasionally brought about grave and even fatal results very suddenly. Whether these have been due to absorption, to reflex nervous disturbance, or to dislodgment of thrombi is uncertain, but it is beyond question that in several cases symptoms of impending collapse, and even death, have followed on washing out an empyema, and that, too, in a patient well on in convalescence. Again, it cannot be too strongly insisted upon that fœtor calls for a freer



opening, not for washing out. If, however, it is decided to make use of injections, dilute and bland ones—*e.g.*, Tr. Iodi—should be used, and these should be gently run in with a funnel and tubing, the elevation of which does not exceed eighteen inches; fluid should never be thrown in with a syringe. Care must be taken that the fluid escapes as fast as it is run in; the patient must always be recumbent.

During the prolonged after-treatment everything should be done to improve the general health. Change of air is here a cardinal point, first getting the patient from his room, then outside the house, and lastly, if possible, to the seaside.*

A point of no small importance in the after-treatment, especially in young subjects with flexible spines, is to encourage early, systematic, deep breathing and gymnastic exercises, thus to promote expansion of the chest, and so minimise that sad sequela of empyema, irremediable lateral curvature.

* "Last, and most important of all—unfortunately for hospital patients a treatment that cannot often be utilised—comes *Margate air*. Any seaside air is beneficial, but, weather and season permitting, I do not believe there is any corner of England so quickly restorative to children with empyema as that in which Margate and Broadstairs are situated; and, personally, I set more store by a change of this kind after the first three or four weeks have passed than in any continuation of antiseptic dressings" (Goodhart, *Dis. of Children*, p. 345).

Before leaving the subject of the operative treatment of empyema, a few words should be said about the dressing of these cases. This should be strictly aseptic from first to last—i.e., cleansing the parts incised, disinfection of instruments, taking care that the pus escapes under an antiseptic atmosphere (p. 869), a sufficiently free opening, adequate drainage, abundant dry gauze and wool dressings, changed twice perhaps in the first twenty-four hours, and then daily for the first week. Later on, when the patient is going to the seaside, he can easily be instructed to remove with clean hands and cleanse daily the short piece of drainage-tube which keeps the external opening patent, and to apply over the sinus a dressing of boracic acid lint and carbolised tow, with a dusting of aristol.

Where an empyema exists on each side, the wisest course is to open and drain one, and at the same time to aspirate the other, which should be opened a few days later. I have three times adopted this course successfully; in each case the patient was a child.

Date at which the Drainage-tube may be dispensed with.—In children with a recent history a few days may suffice; in adults three to four weeks must usually elapse. I have several times succeeded in completing the cure, which would otherwise have been prolonged, by acting on the plan of Mr. Godlee in cases where a slight and serous discharge persists: "The tube is removed and the external opening allowed to close. At the end of a period depending upon the amount of previous discharge, say two or three days, a railroad catheter is pushed along the sinus, and the fluid which has accumulated is drawn off. If this be serous, and not more than a few ounces, another interval of a few days is allowed to elapse, and the same process is repeated. If, at the end of this time, the accumulated fluid is still serous and less in quantity, a still longer interval is allowed to elapse, and when, after several days, it is reduced to a few drachms, the pleura may be safely allowed to deal with it. Should, however, the accumulation remain or become purulent, recourse must again be had to the drainage-tube."

Complications of Empyema and Reasons for Cases not doing Well.—(1) A persistent infected condition, in spite of two openings, free drainage, &c. (2) Failure of the lung to expand, owing to dense adhesions, and also, possibly, to fibroid changes in the lung itself. (3) Tuberculous disease. (4) Lung mischief on the opposite side—e.g., broncho-pneumonia, bronchitis. This is especially dangerous in patients over forty. (5) Caries of the ribs, multiple spontaneous openings, with burrowing sinuses beneath the skin. (6) Age, from the feebler powers of repair and the more rigid condition of the chest as life advances. (7) Cardiac dilatation. (8) Inflammation of other serous and the synovial membranes, e.g., when the pneumococcus is present. (9) Size of the empyema. The smaller and the more localised the collection the better the prognosis. (10) Collection of pus forming in the opposite pleura. (11) A broken-down constitution; intemperance; kidney disease. (12) Mr. Godlee (*Dict. of Surg.*, vol. i. p. 459) reminds us that a curious complication—viz., cerebral abscess—has been noticed in a sufficient number of instances to make it unwise to overlook the possible association of one with the other. Judging from Dr. Fagge's remarks on thoracic disease as a cause of cerebral abscess (*Prin. and Pract. of Med.*, vol. i. p. 546), it would

appear that disease of the lung itself is oftener the primary lesion upon which the abscess of the brain depends.

According to Sir W. Gowers (*Diseases of the Nervous System*, 2nd edit., vol. ii. p. 477), these abscesses "never result from true tubercular cavities; the abscess is single in about half the cases, and is generally situated in the cerebral hemispheres, especially in the posterior lobes. The cerebellum is not often affected, and never suffers alone." Mr. Godlee (*loc. supra cit.*, p. 617) writes: "These abscesses are seldom amenable to surgical treatment. I have opened one without good result, probably because it was not single, and I have searched for one which appeared to give positive evidence of being situated in the motor area, but was really in the occipital lobe."

RESECTION OF RIBS.

Indications.—These are chiefly—

- A. Caries of ribs.
- B. In certain cases of empyema.
- C. For a wound of an intercostal artery.
- D. For removal of growths.

Apart from cases of tuberculous origin, I have resected parts of the fourth, fifth, and sixth ribs, keeping up persistent mammary sinuses, the caries being here due to old abscess of the breast. In another patient I twice resected ribs in operations for extirpation of recurrent cancer of the left breast. Strict antiseptic precautions can alone justify this, as the dressings were placed in immediate contact with the lung and pericardium. The patient remained without further recurrence two years after the resection of the ribs, and eight after the primary operation. A little later I heard that she had died, under the care of a homœopath—I imagine from another recurrence, or from visceral deposits.

Dr. E. Rixford, of San Francisco, in an instructive paper (*Ann. of Surg.*, January, 1906, p. 35), quotes the above case, and shows by four others what surgery in hands as skilful as his own can effect in these comparatively rare cases. He points out that, as, in the modern operation for carcinoma of the breast, all the subcutaneous tissues are removed down to the periosteum and intercostal muscles; if any reappearing nodule is to be successfully dealt with, the underlying portion of the chest wall must be removed with it. The following are the abstracts of Dr. Rixford's four cases. There were no deaths from the operation.

Case I.—Reappearing carcinoma of breast over fifth rib; resection of fourth and fifth ribs; no evidence of reappearance after two years. Case II.—Reappearing carcinoma of breast at edge of sternum; resection of fourth and fifth costal cartilages with edge of sternum; reappearance in mediastinum after eight months, disappearing under the *x*-rays, but reappearing five months later. Case III.—Reappearing carcinoma of breast at edge of sternum; resection of third and fourth costal cartilages with half of breadth of sternum; reappearance in original scar apart from the field of the last operation; death from general carcinosis five months later. Case IV.—Reappearing carcinoma of breast at edge of sternum; removal of ends of first and second ribs and portion of sternum and mediastinal glands; internal mammary artery tied at its origin; further recurrence below; resection of third and fourth ribs; patient well six months after last operation, twenty-two months after operation by Halsted's method.

Dr. Rixford's method of meeting the complication of pneumothorax is given at p. 879.

A. In obstinate *caries*, where more than one rib is affected, where previous treatment, including gouging, fails, resection should be at

once performed. It is a very simple operation in these cases, as the soft tissues are nearly healthy and the periosteum is retained.

An incision, about two inches long, being made over the centre of the carious rib, and the muscles peeled off with a blunt dissector, the periosteum is next incised, and separated from the upper and under aspect with an elevator, blunt and slightly curved, so as to pass readily under the rib and lever it upwards. The rib being thus raised, it is easily divided at one limit of its exposed part, partly with a narrow-bladed saw, partly with sharp, curved cutting-forceps. The soft parts are next peeled away from the under aspect, and the rib divided at the corresponding spot and removed.

B. In certain cases of *empyema*—e.g., (1) when the drainage is insufficient, the discharge foul, in spite of one or two free openings; (2) when the ribs are too close together for a tube of sufficient size; (3) when an *empyema* cavity still persists, though sweet, in spite of free incision, good drainage, and careful dressing. In the first two classes of cases removal of a small piece of one or two ribs, as above described, will be sufficient, but in some of these latter cases the operation will necessarily be a much more severe one. When called to a case of persistent sinus and discharge after the incision of an *empyema*, the surgeon on examination may find that the cavity which remains is *small*, and that the discharge is due to a persistent sinus-track only. This should be dilated with laminaria tents, part of a rib removed, and both sinus and cavity thoroughly curetted. Other causes which have to be thought of where a sinus persists with an *empyema* cavity of small size are:—a small collection of pus after inefficient drainage, caries of a rib, poor vitality of the patient, and a drainage-tube which has slipped into the cavity.

But in the majority of cases of long-standing *empyemata* the *cavity* remaining is an *extensive one*, and the condition of things is not so simple and so easily dealt with. Obliteration has taken place often very imperfectly, owing to the lung not being able to expand, to the ribs having fallen in all they can, to the diaphragm having risen, and the opposite lung, the heart, &c., having come over as far as they are able; while the cavity, often large, which thus remains, is lined with much thickened scar-like tissue, covered with granulations of but poor vitality. Here portions of several ribs must be removed, and the operation perhaps repeated, in order that the walls of the cavity may still further collapse, and thus obliterate the cavity while an opportunity is given for exploring this thoroughly.

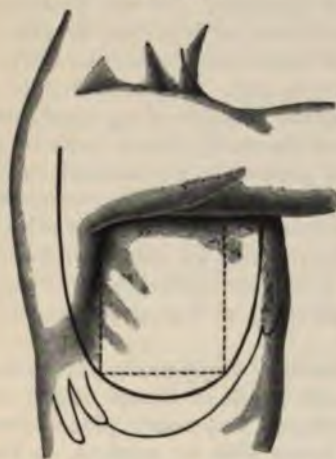
The spot chosen for the resection of the ribs should be, as far as possible, opposite to the lung which can expand no more, and the pieces of ribs removed should correspond as closely as may be to the anterior and posterior limits of the cavity which it is desired to close. The size of the cavity should be estimated as far as possible with the aid of sterilised bougies and pewter probes. But the use of these through a fistula gives very little information. Any really useful estimate can only be arrived at after removal of parts of at least two ribs.

Operation (Fig. 296).—Estländer removed portions of three or four ribs through small incisions. Schede went further, making use of large flaps, removing the ribs more extensively and, in addition, all the periosteum, intercostal structures, and costal pleura over the

empyema cavity. While this operation is based upon sound reasoning, it is usually an extremely severe one, and the patient's vitality and resisting power are often low. In the case of a cavity of moderate size situated anteriorly or antero-laterally, the operation can be quickly done, and a result is obtained in a short time. But in my experience these cases are few. The cavity is usually extensive, and—its worst feature, owing to the rigidity and inability to collapse of the parts behind—it is here, viz., under the scapula and vertebral portion of the ribs, that the chief part of the cavity will be found. Further, it is not only the bones which here add to the difficulties of the operation, but the muscles are larger and the loss of blood greater.

If the surgeon begin by raising an extensive flap, in order to obtain adequate exposure of the cavity, he may find that he has done too much. I advise him to find out what

FIG. 296.



Schede's incision for thoracoplasty. The curved incision shows the large flap, the dotted one the line along which the ribs are resected.

has to be done as his operation proceeds. The first step is to make out the lowest part of the cavity. As a rule the fistula does not correspond to this. As there is not sufficient fluid present to enable an exploratory puncture to decide the lowest level of the empyema, this point must be cleared up with a finger introduced from the fistula, sufficiently dilated, with the additional removal of pieces of one or two ribs here to begin with. The operator having placed himself on safe ground by finding the base of the empyema, begins the central part of his free curved incision here. All the soft parts down to, but not including, the periosteum are raised from the lowest two ribs, and two to three inches of these freely resected. Care must be taken now and later to leave the periosteum on the rib (the only safe guide being not to strip off all the muscular

tissue) and by no means to detach it. If it be left behind, it will throw out material which will be quite as unyielding as the bones taken away. The ribs are removed by carrying a periosteal elevator under them, keeping it close to the posterior aspect, to one limit of the exposed surface, and the bone divided here partly with a strong-backed narrow saw, partly with curved cutting-forceps or rib-shears. The rib is then raised where cut and severed with the shears at its other extremity. Another method is to divide the rib in the centre, and grasping each portion with sequester-forceps, again sever them at their extremities. Each piece of rib removed should show clean-cut edges and be covered with periosteum. Now, and throughout the operation, the finger should keep the surgeon accurately informed as to the limits of the cavity, especially when he approaches these in dividing the ribs. As the use of the fingers is the only way of safely delimiting the cavity, the hands must be repeatedly resterilised.

By thus freely removing two ribs at the lowest part of the cavity, the surgeon has rendered himself safe in this direction, and also obtained access for more complete palpation of the extent of the empyema. We will suppose that it extends anteriorly and posteriorly as well as upwards. The incision down to the bones is enlarged upwards and forwards and the soft parts raised as before; with two or more fingers as a guide, the ribs or costal cartilages, according to the extent of the cavity anteriorly, are cut through successively, the remaining intercostal structures being severed with blunt-pointed scissors. The amount of bleeding now met with will vary with the condition of the costal pleura. If this be much thickened, the intercostal vessels will be partly obliterated, but in every case, owing to the condition of the patient, each vessel is to be clamped and, if possible, tied. This is rendered easier by the free access given. The ribs being severed in front, the incision is prolonged in a curvilinear direction backwards and upwards over this aspect of the empyema, the flap still more raised, and the ribs and intercostal structures severed above and finally behind. If the parts removed do not include the costal pleura, and if this be much altered, thickened, and gristly, it must be taken away. Serious hæmorrhage need not be feared if the structure be snipped through gradually with curved blunt-pointed scissors, any vessels met with being easily secured as they are divided.

If the cavity be a foul one, or coated with ill-formed lymph and granulation tissue, it should be gently wiped over with sterilised gauze and pure carbolic acid, solutions of formalin (1 in 500), or tincture of iodine, or turpentine applied, but no curette should be employed. The danger of this was brought home to me by the following case:

A woman, æt. 56, was admitted under my care with a right-sided empyema cavity of some months' duration and foetid discharge. The left lung was evidently the seat of bronchitis. The cavity, moderate in size and antero-lateral, was easily dealt with on the lines given above. Believing that toxæmia from the very foul condition of the cavity largely explained the condition of the patient, I thoroughly curetted the lining membrane, trying to exercise especial care where I approached what might be the root of the lung, pericardium, &c. The next morning the right foot was noticed to be cold. Gangrene followed, necessitating amputation above the knee joint, the patient sinking four days later. The necropsy did not clear up the spot whence the thrombus had been detached. The left lung was the seat of tuberculous mischief.

In such foul cavities, packing with gauze wrung out of formalin solution (1 to 500), or the old-fashioned remedy, turpentine, should be employed. In the latter case only the ends of the strips should be thus soaked, the turpentine not being allowed to come in contact with the skin. In no case should iodoform be employed, owing to the large absorbent surface and the condition of the patient.

The flap of soft parts, however large and bulky it may have appeared, will always prove too scanty for the covering in of the gap left. It must be fastened well depressed, so that it is in contact with the lung, by means of a few salmon-gut sutures and large gauze pads. "Decortication" of the lung is referred to later.

An operation performed on the above lines, with the view of obtaining a thorough exploration of the cavity and then the gradual removal of all ribs and pleura that is needful, is, in my opinion, the one best adapted to the largest number of cases. But owing to the condition

of the majority of the patients, the operator must be prepared for having his hand stayed, and the need of completing the removal of the needful parts in more than one stage. While such later operations destroy in a measure what has been gained at the first, it is the choice of a lesser evil, and the patient or the friends must be prepared for it.

A few points still need to be referred to.

Where the greater part of the cavity proves to be posterior, in the vertebro-scapular region (p. 874), the condition of the patient will be the chief guide. The improvement in these cases, local and general, brought about by a well-executed operation in front is always, in my experience, very great. If the condition of the patient justify further attempts at obtaining an absolute cure, the choice lies between removal of the lower part of the scapula by a continuation backwards of the posterior horn of the free curved incision (Fig. 296), or resection of the posterior parts of the ribs by raising a trap-door-shaped flap over them, between the vertebrae and the scapula. Continental surgeons have frequently employed the first method. C. Beck, of New York, mentions (*Ann. of Surg.*, 1904, vol. i. p. 419) two cases in which he removed the lower part of the scapula, one in a boy of 6½, as part of a single operation, complete healing following. In the other case, a man of 40, the lower part of the scapula was taken away in the last of a series of seven operations. The cavity had now gradually filled up, but a large defect was still left where the axillary region was not yet covered by skin. The same surgeon (*ibidem*, p. 416) advises the following method in those rarer cases where the persistence of the trouble is due to the main cavity being apical. The increased local risk here, owing to the vicinity of the subclavian vessels and the fixity of the parts, is obvious.

"With the arm at right angles, the incision is led close to the lower border of the pectoralis major till it ends at the lower part of the anterior margin of the deltoid. The muscles are then dissected superiorly until the axillary region is free. The vessels and muscles are grasped by strong blunt hooks and pulled upwards. Sometimes separation is possible only by the aid of lateral incisions into both pectorals. Thus the vessels are temporarily put *hors de combat*, and the ribs can be removed according to the indicated principles. If it is very difficult to reach the first rib by means of the pectoro-axillary incision, then the clavicle is to be resected temporarily."

Decortication of the Lung.—Removal of the pulmonary pleura with the view of allowing the lung to expand was advocated by Delorme in 1894 (*Amer. Year-book of Med. and Surg.*, 1902) and G. R. Fowler (*ibidem* and *Med. News*, June 15, 1901). It has been claimed that this method should largely replace the operations of Estländer and Schede, but as, owing to the usual position of the lung, free removal of the overlying parts will be first needful, it appears to me to increase considerably the severity of an operation already very great. In my experience, the visceral pleura is rarely in that thickened altered condition with which we are so familiar in the case of the costal pleura. Lastly—and this is my chief objection—even if the visceral pleura be successfully removed over the needful extent—and the movements of the diaphragm and pericardium are sure to be embarrassing—the lung will not expand, as far as my experience leads me. It is not from within, but from without, by sufficiently extensive removal of the rigid overlying parts, that we must hope to gain the obliteration of the cavity.

In all these operations precautions against shock must be taken before and during as well as after their performance, and it is always well to have a supply of oxygen at hand.

With regard to the date at which ribs should be partially resected in long-standing cases of empyema, most surgeons who have seen much of these troublesome cases will, I think, agree that the operation should be performed as soon as the natural powers of obliteration are

at a standstill, care being taken that the patient has recovered from the effects of the first operation, and perhaps recruited his strength at the seaside. About three months will be a sufficient interval, as a rule. Waiting longer only encourages local and general conditions which affect the operation unfavourably.

C. *Wound of Intercostal or Internal Mammary Artery*.—When hæmorrhage from one of these vessels cannot be otherwise dealt with, removal of a rib will give much readier access to the spot, and a ligature will arrest the bleeding far more satisfactorily than the ingenious devices mentioned in the text-books.

D. *For Removal of Growths*.—An attempt may be justifiably made to remove a growth arising from the ribs if the following *conditions* are *favourable*. The growth should be of moderate size, not involving parts of more than four ribs; its history should be a slow one; its outline should be nodulated, well defined, and its surface hard, pointing to a chondroma or osteo-chondroma, the skin over it thinned, perhaps, but not infiltrated. There should be no dulness in the neighbourhood of the growth, the breath sounds should be normal, and there should be no enlargement of the axillary or the inguinal glands. The following is a successful case:

Zarübin, of Kharkov, related (*Trans. of the Kharkov University Society*, 1891, *Supplement to Brit. Med. Journ.*, Aug. 1, 1891) the case of a young Cossack who sought his advice for a steadily growing and occasionally painful tumour of seven years' standing. It measured 21 centimetres horizontally, and 19 vertically, occupying the right side of the chest between the nipple and the post-axillary line from the sixth to the ninth rib. The new growth was hard, nodulated, immovable, and non-adherent to the skin. The integuments over it were thinned, but otherwise normal, and the nearest lymphatic glands apparently unaffected. An osteo-chondroma of the thoracic wall was diagnosed. The huge mass was removed, together with the involved portions of the seventh, eighth, and ninth ribs. The gap left in the chest measured 17 centimetres in a horizontal, and 16 in a vertical direction. On opening the thoracic cavity the lung collapsed, but only partially, owing to pleural adhesions around the periphery of the new growths. No serious respiratory or cardiac disturbances occurred, and the hæmorrhage was only trifling. The cavity was gently cleansed with gauze soaked in a 1 per cent. solution of boracic acid, and the skin wound, conical in shape, closed. The growth, much larger than an adult head, weighed over 6 lbs. For the first two days the patient was much collapsed and cyanosed, and suffered from agonising cough and obstinate vomiting. The healing of the wound was complete in two months. The author alludes to ten other cases of resection of the thoracic wall for new growths, of which six recovered, while four died.

The two following cases (*Trs. Amer. Surg. Assoc.*, 1901, pp. 383, 494) illustrate most of the points in operations on these cases:

Case I. was under the care of Prof. Keen, of Philadelphia. A woman, æt. 25, noticed a swelling about the size of an egg near the angle of the right scapula three months after an injury to the right side. On admission eight months later, she presented a swelling in the postero-lateral aspect of the right chest, extending from the erector spinæ to the right breast, and from the fifth to the eleventh ribs inclusive. The skin was not infected, and there was no evidence that the lung was involved. On exposure of the growth by a horseshoe-shaped flap it was found to be mushroom-like, with an attachment much smaller than the main mass. In order to remove as little of the chest wall as possible Prof. Keen first separated the growth gradually from the ribs, of which the fifth, sixth, seventh, and eighth, with the intervening tissues, were involved. The pleura was next separated from the anterior surface of the ribs with a periosteal elevator, and each of the four ribs mentioned above divided with forceps anteriorly and posteriorly without opening

the pleural cavity. With scissors the soft parts, including the pleura, were rapidly divided, an aperture being thus made in the chest wall measuring 18 cm. vertically by 12 transversely. The patient "suffered very little indeed" from the pneumothorax, which was dealt with by the operator drawing the lung up into the opening with his hand and suturing it to the circumference of the opening with a continuous catgut suture. The patient recovered, and seven months later there was no evidence of reappearance of the disease. The growth was a mixed spindle-celled sarcoma.

Case II.—A man, *set.* 41, was admitted under the care of Dr. C. B. Porter, of Boston, with the history of three months' pain and swelling in the right side. A dome-shaped swelling, the size of half a cocoa-nut, was present with its centre at the level of the eighth rib in the anterior axillary line. There was no evidence of involvement of the lung. By a flap-incision the greenish-black capsule of the growth was exposed. On opening this severe hæmorrhage took place, only controlled by curetting away the growth from the ribs. Of these the seventh, eighth, and ninth were divided in the mid-axillary line, three-fourths of an inch from the growth. On elevating the ends of the cut ribs the lung was seen partially collapsed. The sudden shock now anticipated was not experienced. The intercostal muscles between the sixth and seventh ribs were next divided, with the costo-chondral ligaments and cartilage. On elevating the upper portion of the ribs thus divided, the growth was found to have extended into the pleural cavity, its intra-thoracic portion being covered by parietal pleura. The intercostal muscles, costo-chondral ligaments, and cartilages of the ninth and tenth ribs were next divided. It was now found that the lower end of the intra-thoracic growth was adherent to the diaphragm. As it could not be dissected away, the diaphragm was cut through by an elliptical incision, half an inch from the margins of the growth; the ribs, piece of diaphragm, and growth were removed together. When the diaphragm was opened the intestines came through; they were replaced and held back by gauze while the opening was sutured. The pleural cavity was drained by gauze. Considerable shock supervened, coming on gradually and not due to the pneumothorax. Dyspnoea was much relieved by oxygen administered during the first week. About a month after the operation it was necessary to reopen the upper end of the incision to evacuate several ounces of serum. The patient was seen sixteen months after the operation with no evidence of reappearance of the growth. A hernia of the lung was present, due in part to the patient's work in a stooping position. The growth was chiefly a giant-celled sarcoma originating in one of the ribs.

The conditions contraindicating operation will be made plain from those already given. Cases of sarcoma dating to an injury and of rapid growth, and those of secondary origin, *e.g.*, after an amputation of a limb, should be left untouched, owing to the probable involvement of lungs, liver, &c., and the certainty of rapid recurrence. I need not remind my readers of the few physical signs present when nodules of malignant disease are scattered through the lungs.

The occurrence of pneumothorax is the complication which chiefly requires attention. While rightly dreaded, and while special means have been devised to meet it, it is clear from the cases published that, as long as the entrance of air is not large and sudden, operations involving partial removal of one side may be safely completed without the need of any especial devices* or of resorting to artificial respiration. The means adopted have been dragging up the lung with blunt-nosed forceps, attaching it by sutures to the margin of the wound, and the

* Of these the cabinet of Dr. Sauerbruck, by which intra-thoracic operations can be performed under negative air pressure, is the chief. The experiments of this surgeon were carried out at the suggestion of the late V. Mickulicz (*Centr. f. Chir.*, Feb. 13, 1904; *Mitteilungen aus d. Grenzgebieten d. Med. und Chir.*, Bd. xiii.; *Deut. Med. Woch.*, April 14, 1904). An account of Dr. Sauerbruck's work is given by Dr. W. Meyer, of New York, who, ever in the van of advanced surgery, paid a visit to Breslau in 1894 (*Ann. of Surg.*, May, 1905). This paper is referred to at p. 889.

use of tampons. On this point Dr. E. Rixford, of San Francisco, writes of his cases in which he removed part of the chest wall for reappearing carcinoma of the breast (p. 872): "In these cases there were no untoward symptoms incident to the production of pneumothorax. It was noticed, of course, that the respiration became immediately deeper and more rapid as soon as air entered the pleural cavity, but, aside from the violent flopping of the heart from right to left, terrifying to look at but without noticeable effect on the pulse, there was no especial inconvenience to patient or operator. . . . In the cases here reported the writer found that the respiration could be greatly modified, and the tremendous lateral excursions of the heart and mediastinal tissues almost completely checked, by the simple procedure of stopping up the opening in the chest wall with a wet towel. The towel, folded into two or three thicknesses, is made to slip beneath the partially loosened section of chest wall which is to be removed, and is drawn forwards as new cuts are made. It is important to close the opening at the moment of complete expiration, when the chest is largely emptied of air. When this was done the lung expanded, and the exaggerated and fatiguing expiratory efforts were at once quieted."

Thus far removal of *growths from the ribs* has been considered. *Those affecting the sternum* are rarer.

Prof. Keen (*Med. and Surg. Rep.*, March 27, 1897) relates a case in which he resected the manubrium, inner third of left clavicle, and lower third of the sterno-mastoid for a sarcoma. The muscle was divided first at the junction of its middle and lower thirds, and the inner end of the left clavicle removed. The cartilage of the first rib having been divided about one inch from the sternum, and the soft parts behind the sternum separated with the finger, the manubrium was divided horizontally just above its junction with the gladiolus. Fifteen months after the operation there was no reappearance of the growths. A list of seventeen other cases in which resection of the sternum was performed for growths is given.

One of the most interesting lessons given by these is from a case of König's (*Centr. f. Chir.*, 1882, Bd. xlii.) in which the disease, "osteoid chondroma," reappeared in the lung two years after the operation.

Dr. P. B. Griffiths, of Cardiff, records a case of resection of the sternum for sarcoma (*Lancet*, October 11, 1902). The most interesting feature is that, while the growth appeared to be well defined and limited, its extensions were wide and deep. Complete removal was impossible. In this case also but slight shock was noticed when one pleural cavity was opened. The patient survived four months. The necropsy showed the existence of deposits in both pleurae, in the liver, and about the spine below the pancreas.

OPERATIVE INTERFERENCE IN INJURIES OF THE CHEST.

Reference here will first be made to a most important class of injury occasionally met with in hospital practice, viz.,

Penetrating Wounds of Chest involving the Diaphragm and Contents of the Abdomen.—Owing to the rarity of the use of the knife and revolver in this country, the only safe teaching comes from America and the Continent.

Dr. D. H. Williams, of Chicago (*Ann. Surg.*, 1904, vol. ii, p. 675), draws the following conclusions. In many penetrating wounds of the chest hermetic sealing of any wounds and conservative treatment is indicated where there is no evidence of injury to the heart, internal mammary or intercostal vessels. Wounds below the fifth rib, especially on the left side, should

be explored in order to ascertain whether the diaphragm and abdominal viscera have been injured. Without such exploration no diagnosis can be made until, perhaps, it is too late. Parts of the fifth to the eighth rib, according to the site of the wound, having been resected,* if the injury be on the left side, any opening in the diaphragm will probably be found filled with omentum. This is cleansed and reduced into the abdomen, and the opening closed with a purse-string stitch. The incision is now extended over the left lateral abdominal wall into the abdomen, and the condition of the liver, spleen, kidney, and colon investigated. Three most instructive cases are given in which injuries to some of the above viscera were operated on with complete success.

Modern Gunshot Injuries of the Chest.—Such recent wars as that in South Africa and the American one in the Philippines show that wounds of the chest are the most hopeful of all visceral injuries. Wounds of the large vessels, roots of the lung and heart, and those involving the abdomen also (p. 879) are exceptions. G. H. Makins, C.B. (*Surg. Exper. in South Africa*, p. 382), states that the frequent escape of the thoracic viscera from injury, putting aside the lungs, was remarkable; and that, as a rule, the frequent pulmonary wounds needed little interference on the part of the surgeon. While pneumothorax was rare, hæmothorax was the most frequent of the complications of wounds of the chest. In 90 per cent. or more of the cases, the hæmorrhage was of parietal source. With regard to the treatment of hæmothorax, if rest was employed early, few serious cases occurred. For hæmothorax of a later date Mr. Makins lays down the following rules:—(1) Hæmothorax, even of considerable severity, will undergo spontaneous cure. An early rise of temperature may be disregarded. (2) Tapping is indicated when pressure on the lung causes serious symptoms. In such cases the collection has usually been rapid; hence a fresh hæmorrhage is always probable when the local pressure has been removed. Evacuation, therefore, should not be necessarily complete, and should be followed by the most absolute rest. (3) Tapping may be needed as a diagnostic aid, or (4) for the evacuation of serum expressed from the clot. (5) Early free incision is, as a rule, to be steadfastly avoided. (6) Incision and ligature of a parietal artery are very rarely needed. (7) If a hæmothorax suppurates, it must be treated on the ordinary lines of an empyema. As to primary empyema, Mr. Makins only saw one case which illustrated the disadvantages of extracting bullets on the field where the conditions present prevent the ensurance of asepsis. In the early part of the campaign secondary empyemata not uncommonly followed drainage of a hæmothorax. At this time an early rise of temperature was believed to be due to breaking down of the clot. Subsequent experience showed that this was not the case. Owing to the difficulty in clearing out the clot and the need of drainage, suppuration was common, and most troublesome, small collections usually forming and late residual abscesses following not infrequently.

* The operator must now be prepared for the risks of pulmonary collapse and pneumothorax (p. 878).

CHAPTER III.

OPERATIONS ON THE LUNG.

OPERATIVE interference may be required in the following conditions:—(1) Abscess of the lung. The following are the chief varieties: (a) acute abscess, *e.g.*, after pneumonia, (b) chronic, non-tuberculous, (c) that due to a foreign body, and (d) to tubercle. (2) Gangrene of the lung. (3) Hydatid disease. (4) Bronchiectasis.

With regard to the indications for operation, Mr. Godlee, one of the chief authorities, holds that, if an *acute abscess* following on pneumonia be suspected to exist, an attempt should be made to reach it from outside, except when the abscess has burst quite recently into a bronchus. When this has occurred, a short time should be allowed to elapse in order to see whether a cure is likely to result. This is rare owing to the usual insufficiency of the opening and to the mischief spreading locally in the same lung, and to the opposite one. If, in a day or two, there is not a notable diminution in discharge and a fall in temperature, an opening should be made. *Gangrenous cavities* should always be sought, and, if possible, opened; the prognosis, if the operation is successful, is not bad.

In the case of *cavities caused by a foreign body in the bronchus*, the following practical points are insisted upon by Mr. Godlee. (1) That a very short residence of a foreign body in a bronchus may give rise to an amount of damage from which recovery is impossible. (2) That while the onset of this is much more rapid in a rough or sharp body, a smooth body will eventually set up so much dilatation of the bronchi and consolidation that it is important in every case of unilateral bronchiectasis to enquire as to the possibility of its having arisen from the inspiration of a foreign body. In a recent case, the treatment given at p. 653 should be adopted without delay. In chronic cases, the site of the foreign body and abscess should be determined if possible, and these should be dealt with on the lines given at p. 884. If these fail,* tracheotomy should be performed and the same course pursued as in cases of recent impaction. Another method is to make an incision behind, and to examine the back of the lung (Figs. 299, 300). If the search fails, a drainage-tube should be retained for some time in the hope that the foreign body may be expelled through this opening.

Andrews records (*Lancet*, May 9, 1903) an unsuccessful attempt to

* If on opening an abscess connected with a foreign body the latter be not found, it must be remembered that, if of any considerable size, it probably lies pretty near the middle line. (Godlee.)

remove a foreign body from one of the main divisions of the left bronchus by posterior bronchotomy.

The patient was a boy æt. 15, and the foreign body the "squeaker" of a doll. There was no doubt about the position of the foreign body. Two unsuccessful attempts having been made to remove it by tracheotomy, Andrews resected portions of the ribs from the third to the sixth, between the vertebral column and the scapula. The lung and divisions of the bronchus were explored, but the position of the body could not be defined. The opening later suppurated, and required drainage. The patient for some time expectorated purulent material; he ultimately recovered, though the foreign body was never seen. A skiagram taken after recovery failed to show any foreign body, though one taken the night before the operation showed it plainly. Its disappearance could in no way be explained. The literature of the operation will be found referred to.

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By means of puncture in one or more places, not only may the pus or fluid be found, and the cavity thus localised, but valuable information with regard to the presence of adhesions between the lung and the pleura may be obtained; for if the needle does not oscillate synchronously with the movements of respiration, adhesions are certainly present. On the other hand, the exploring needle will fail where the

remove a foreign body from one of the main divisions of the left bronchus by posterior bronchotomy.

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cavity is deeply placed, where it is masked by consolidated lung, and where it is multiple; also when the cavity is empty owing to recent expectoration of its contents, or again, where it only contains thick pus. Moreover, Mr. Godlee's words (*Lancet*, 1887, vol. i. p. 459) on this point should be remembered; he says, "It is impossible to penetrate the lung with any amount of accuracy or definiteness, because it recedes before even the sharp point of a needle."

Operation.—This will be described on general lines, calculated to meet the different conditions which may call for it. The anæsthetic should be given slowly to avoid coughing, and the patient kept as much as possible on the back over the edge of the table. This is a good position for the patient, but it necessitates the surgeon doing most of the operation either seated low or kneeling. The above two precautions are intended to prevent fluid, coughed out of the cavity, dangerously obstructing the bronchi. Chloroform, or the A.C.E. mixture should be the anæsthetic chosen in these cases, in order to avoid the coughing and congestion produced by ether.

The needle by which the fluid has been found is itself taken as a guide, and must not be displaced by any subsequent manipulations. An incision three inches long is then made over the middle of the rib nearest to the puncture. This incision goes down directly on to the bone. The periosteum is now divided over the exposed area of rib, and separated from the bone by means of a slightly curved raspatory, care being taken to thoroughly detach the periosteum from the deep aspect of the rib. The portion of rib thus exposed is now divided in front and behind with cutting-forceps or saw, and removed. The pleura is now carefully exposed by incision of the periosteum, and the question of the presence or absence of adhesions determined. In settling this question, the pleura, if not adherent, must not be injured. If no thickening of the pleura is found, and the lung can be seen freely moving beneath it, means must be taken to shut off the pleural cavity before the lung cavity is opened. Absence of adhesions, however, will only be found in acute conditions, and even then quite rarely. The best treatment under such circumstances is to unite the lung and pleura together by a continuous suture over a sufficient area, and wait forty-eight hours before completing the operation. The sutures should take up about half an inch of the lung, to ensure their holding, and if there be still the least sucking-in of air, additional ones should be inserted. While this is much the best means of preventing pneumothorax and entrance of fluids into the pleural sac, another means of securing the same ends is to seize the lung with blunt-nosed forceps as soon as the pleura is incised, and to quickly draw it up into the wound.

The next step in the operation consists in opening the cavity in the lung. This is best done with a medium-sized trocar and cannula, the opening so made being dilated with dressing-forceps. The finger is then gently inserted to ascertain whether any dead cast-off lung tissue, or, in the case of an abscess, a foreign body, is present.

A full-sized drainage-tube (soft, for fear of hæmorrhage from friction and ulceration) should be inserted: where the discharge is foul, boracic acid fomentations should be applied.

Hæmorrhage is not commonly met with after puncturing the lung,

as this is probably solidified and altered round the abscess cavity. If it be severe, the cavity must be plugged with aseptic gauze wrung out of turpentine. The cautery has the objections previously given, of rendering the feel of the tissues confusing, and perhaps leading later to infection of the wound. When any rotten lung-tissue has been removed with the finger, hæmorrhage is to be expected.

If the cavity be due to an hydatid (p. 882), the endocyst may perhaps be expelled when coughing is set up by the incision of the cavity. If it does not so come away, it should be removed, if this can be effected without setting up hæmorrhage. To render this step safe, the cut edges of the cyst should be sutured, with the cyst wall, to the external wound, or the edges of the cyst kept well drawn up with blunt-nosed forceps. The after-treatment is here especially likely to be tedious.

A good instance of how large cavities in the lungs may be, when due to this cause, is given by a case of Dr. Fenger's (*Lond. Med. Record*, 1881, p. 327), in which he successfully operated by an incision in the third space (through adherent pleura), for a gangrenous hydatid cavity in the right lung, reaching from the second to the fifth rib, and from the sternum to the posterior axillary line.

After-treatment.—The cavity should be syringed out with a 1 in 50 solution of carbolic acid till fœtor disappears, and then with thymol lotion. If fœtor is obstinate, gentle plugging with gauze wrung out of turpentine should be tried. The drainage-tube must reach to the end of the cavity, and should have several holes at its extremity; it should not be changed for a day or two until its reintroduction has been rendered easy; finally, it must be retained until the cavity has almost completely closed—i.e., until the discharge has almost, and the expectoration has quite, stopped. If the tube be removed too early, refilling of the cavity, with return of fever, nausea, expectoration, &c., is certain. Moreover, as the external opening tends to close before the cavity is obliterated, any foul remaining matter which does not escape may be drawn into the bronchi and set up diffuse bronchitis and broncho-pneumonia.

The general health must be sustained, and every attempt made to secure fresh air, whether in the patient's room, or by getting him as soon as possible into another room, and out of doors.

Even if the operation does not save life, it may make the remainder much more comfortable both to the patient and his friends.

Dangers and Difficulties in Opening a Lung Cavity.

1. Dyspnœa, coughing, and choking expectoration with the anæsthetic.
2. Pleural adhesions absent (p. 884), or so soft that they easily break down, the lung thus being pushed away from the ribs (Godlee).
3. Missing the cavity and damaging healthy lung tissue. This is best avoided by careful preliminary use of an aseptic fine trocar or large morphia-needle.
4. Getting, as a result of the operation, diffuse broncho-pneumonia, pleurisy, or pleuro-pneumonia, in the lung operated on or its fellow.
5. Severe hæmorrhage, causing much trouble, owing to the hæmoptysis with the anæsthetic (Godlee), and later on setting up infective inflammation of the lung.

6. Finding a large branching cavity, with numerous caverns, difficult or impossible to drain.

7. If the bronchi are dilated and contain fluid similar to a cavity, this may be drawn from a bronchus by preliminary puncture. This is then mistaken for a cavity, and cut down upon.

8. A cavity near the large vessels at the root of the lung.

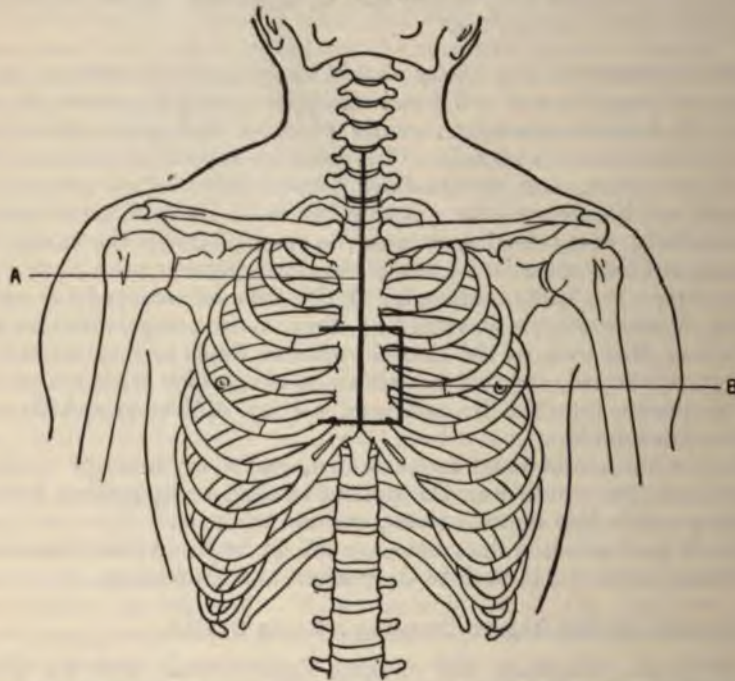
9. Much consolidation of the lung tissue over the cavity.

10. As a result of the operative interference, secondary rapid sloughing and gangrene of the lung may follow.

OPERATIONS ON THE MEDIASTINA.

The indications for interference will be chiefly for inflammatory conditions, acute and chronic. For both, the anterior mediastinum

FIG. 297.



Incisions for exposing the mediastina:—A, Incision for Milton's anterior mediastinal thoracotomy, for exposing the superior, anterior, and middle mediastina; B, Incision for anterior thoracotomy by an osteoplastic resection of the part of the sternum corresponding with the third, fourth, and fifth costal cartilages (exposing the anterior and middle mediastina). (Bickham.)

offers the more favourable field. In the case of the posterior mediastinum, injury or disease of the œsophagus are of especial importance.

Operation on the Anterior Mediastinum (Figs. 297 and 298). In the case of *suppuration*, if there be any sinus or evidence of pointing at

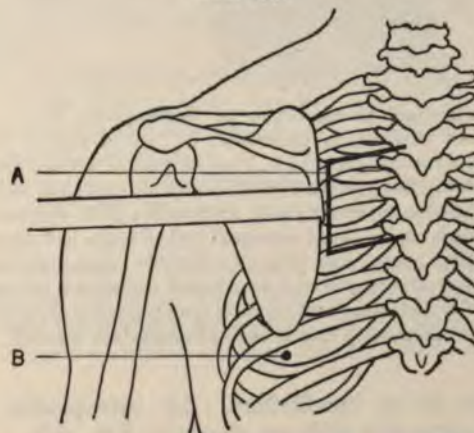
the side of the sternum, the deep opening is enlarged with a finger as a guide, by removal of as much of the sternum and ribs as is needful. The field of operation must be exposed by a flap appropriate to the

FIG. 298.



Anterior mediastinal thoracotomy, by an osteoplastic flap consisting of soft parts and sternum corresponding with third, fourth, and fifth costal cartilages :— A, Osteoplastic flap turned to left ; B, Pectoralis major muscle ; C, C, Intercostal arteries ; D, Costal cartilage divided ; E, Costal cartilage partly broken in hinging back the flap ; F, F, Drill-holes for wiring ; G, Triangularis sterni muscle ; H, H, Lungs and pleuræ, the latter extending further toward the middle line ; I, Heart and pericardium. (Bickham.)

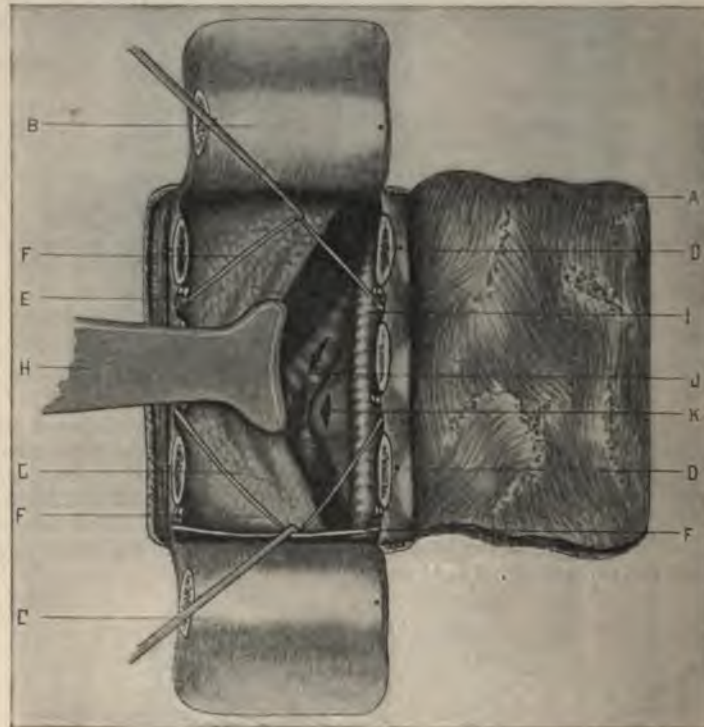
FIG. 299.



Operations upon the thoracic cavity :—A, Posterior mediastinal thoracotomy, by thoracoplastic flap ; B, Position for paracentesis thoracis in the eighth intercostal space in the line of the inferior angle of the scapula. The scapula is here represented retracted slightly outward, to increase working-space between vertebræ and scapula in the removal of parts of the fourth, fifth, and sixth ribs. (Bickham.)

conditions found in each case. Where there is no such evidence to help, the surgeon has two chief means of exposing the anterior mediastinum, viz., two trephine-openings and cutting away the bone between them with forceps, or Milton's method of splitting the sternum vertically with saw and chisel and pulling the two halves forcibly apart (Fig. 297, *Lancet*, March 27, 1897). A single trephine opening

FIG. 300.



Posterior mediastinal thoracotomy, by thoracoplastic flap:—A, Skin and muscle flap turned horizontally backward; B, Flap of part of fourth rib and intercostal muscles turned upward; C, Flap of part of sixth rib and intercostal muscles turned downward; D, D, Vertebral ends of fourth and sixth ribs, drilled for wiring; E, Intercostal artery, vein, and nerve; F, F, F, Fourth, fifth, and sixth dorsal nerves exposed and retracted; G, Pleura and lung; H, Broad retractor displacing pleura and lung; I, Thoracic aorta; J, Left bronchus; K, Oesophagus protruded into wound by a sound introduced through the mouth. The operations of bronchotomy and thoracic oesophagotomy are shown at J and K respectively. The pulmonary and bronchial vessels are omitted, for clearness. (Bickham.)

is almost certain to be insufficient. An osteoplastic flap and the relations of the parts met with are shown in Fig. 298.

Owing to the gravity of infection of the cellular tissue in this region, the importance of adjacent organs and the difficulty of drainage with a patient in the recumbent position, the cavities of the wound should be carefully packed with wet gauze, a sublimate solution being preferable, and this packing should be renewed for the first few days.

With regard to growths of the anterior mediastinum, the one in which surgical interference is most justifiable is the rare one of dermoid cyst. A paper by Dr. Christian (*Med. Surg. Rep.* of the Boston City Hospital, 1901, p. 114), in which he has collected forty cases of dermoid cysts and teratomata in this region, with references to the literature, contains the best English information on this subject with which I am acquainted.

Operation on Posterior Mediastinum (Figs. 299 and 300). We will suppose that removal of a *foreign body* from the œsophagus or one of the bronchi is called for. The patient is placed in the semi-prone position, and the scapula drawn outwards. The thick skin in this neighbourhood will require very careful sterilisation. An incision, four inches long, is made parallel to the vertebral column and about three inches from it, over the ribs from the third to the sixth, and at each end transverse incisions are carried inwards. The musculo-cutaneous flap thus marked out is turned inwards towards the vertebræ. The subjacent portions of ribs are next resected subperiosteally. To obtain the necessary access, the resection must be carried with bone forceps as near the spine as possible, the transverse processes being also removed in part. Especial care must be taken to avoid injury to the pleura. König's and Küster's advice that an assistant follow the operator with a dossil of gauze in case any opening is made in this membrane must be remembered. Any such opening should be sutured at once. All bleeding being arrested, the pleura is carefully detached with the fingers, and the lung pushed inwards and forwards. The presence of a bougie will facilitate palpation of the œsophagus. This is carefully separated from its surroundings, and the bougie being partially withdrawn the œsophagus is drawn into the wound between two forceps, opened, and the foreign body withdrawn. During the manipulations of the œsophagus, the trunks of the vagi will require especial attention, and the vena azygos, if met with, must either be drawn aside with a blunt hook, or secured between double ligatures.

The question of complete suture of the œsophagus must depend on the character of the foreign body and the amount of damage inflicted by this and the necessary manipulations. Sufficient drainage of the mediastinum itself is imperative.

Those interested in trans-thoracic resection of the œsophagus should refer to Dr. W. Meyer's paper (*Ann. of Surg.*, May, 1905), with its account of the work done in this direction by Sauerbruch and the late v. Mikulicz. Reference to the paper will show that dogs were the subjects operated on. Dr. Meyer states that the three resections of the œsophagus performed on the human subject within Sauerbruch's closed chamber at the Breslau Clinic had each resulted in death.

CHAPTER IV.

TAPPING OR INCISING THE PERICARDIUM. SUTURE OF WOUNDS OF THE HEART.

TAPPING OR INCISING THE PERICARDIUM.

Indications.

1. When a pericardial effusion has resisted previous treatment, and signs of cardiac distress are increasing.
2. When there is a steady increase of præcordial dulness.
3. When the heart-beat and pulse are becoming feeble.
4. When cyanosis, dyspnoea, and epigastric distress are present.
5. When the effusion persists, when it is accompanied by œdema, rigors, and pyæmia, *e.g.*, in cases of osteomyelitis, when it occurs in a much weakened patient, the fluid is probably purulent.

The spot usually chosen for puncture is the fifth or fourth space, about one inch from the sternum, so as to avoid the internal mammary vessels, and, if possible, the pleura, which varies greatly in the extent to which it lies under cover of the inner ends of the fifth and sixth cartilages and even of the sternum. Mr. Rowlands (*loc. infra cit.*, p. 892) writes on this point: "From anatomical considerations and experiments on the cadaver it is certain that the safest point to tap or to insert the needle of the exploring syringe is the left costo-xiphoid angle as suggested by Roberts years ago. The instrument should touch the lower end of the gladiolus and should pass backwards, upwards, and a little inwards behind the sternum, until it is felt to enter the cavity of the pericardium at a distance of not more than $2\frac{1}{2}$ inches from the skin. The pleura and internal mammary vessels are too far out to be injured, and the peritoneum too low, and the heart, unless adherent in front, lies too far back in its distended sac to be reached if the above precautions are taken. The inner extremity of the fifth left space is probably the next best situation, where the needle should be passed backwards and inwards in close contact with the sternal edge; but though the internal mammary vessels are quite safe, the pleura will certainly be pierced occasionally. The sixth left space is to be preferred, if wide enough at its sternal end, which is not often the case."

Whichever site is chosen for puncture, strict aseptic precautions must be taken, and the following risks of paracentesis must be remembered, *viz.*, pleurisy, empyema and injury to the heart. While upwards of a pint of serum has been removed in some cases, the withdrawal of only three or five ounces has been followed by recovery.*

* With regard to the amount to be withdrawn, Dr. Stewart (*Edin. Med. Journ.*, Aug. 1885) thinks that, if serous fluid is found, aspiration should be made use of, but only

On the fluid ceasing to flow, the puncture should be closed with sterilised gauze, collodion and iodoform.

In a few cases the collection of fluid lies posterior to the heart. Five and twenty years ago I was asked to perform paracentesis in a patient who was moribund. Only a few ounces escaped, and the patient dying shortly afterwards, the main collection was found to be behind the heart. Thayer (*John Hopkins Hosp. Bull.*, 1904, p. 149) found no fluid on aspiration though the area of dulness was large. At the necropsy, 1200 cc. of fluid were found in the pericardium. Though the heart was not fixed by adhesions it lay in front of the effusion, and the needle had come in contact with this viscus. In such cases, to obtain better access, a rib must be resected.

In some cases the co-existence of effusion into the pleural and peritoneal sacs must be remembered.

If pus is present the case must be treated by free incision. An anæsthetic having been given,* the trocar is taken as a guiding director, and a narrow, sharp-pointed bistoury carefully thrust in by its side; the opening is then further dilated with dressing-forceps or a blunt-pointed bistoury, care being taken to keep the internal opening into the pericardial sac free. A soft drainage-tube should next be inserted, and, when all the pus that will come away has escaped, antiseptic gauze dressings should be applied.

As, however, the proximity of the costal cartilages to one another will only allow of the introduction of a small-sized drainage-tube, and as flocculent matter may be present, *e.g.*, where the pneumococcus is present (p. 867), it is wiser to resect part of the fifth costal cartilage (Fig. 301), or the seventh (Rowlands, *vide infra*). This, while increasing the length of time occupied by the operation, will allow of the insertion of a large drainage-tube, and thus of free and efficient drainage.

An incision is made from the sternum outwards over the fifth costal cartilage to its junction with the rib. The soft parts are carefully separated as at p. 884, care being taken not to wound the pleura. The cartilage is then divided with a narrow saw and sharp bone-forceps at its junction with the rib and sternum. The internal mammary vessels now exposed are divided between two ligatures or drawn aside. The triangularis sterni is detached from the sternum and drawn inwards. The pleura, the relation of which to the chest-wall and pericardium varies greatly, is peeled aside and drawn outwards. It is much thinner than the pericardium and its border may contain fat. If there be difficulty in displacing the pleura outwards, the adjacent part of the sternum should be removed (Rowlands). In children, owing to its cartilaginous nature, this is readily effected with a gouge. A little further use of a director will now expose the pericardium. Before this is incised it is well to again use an exploring needle. The incision into this sac should

enough withdrawn to give relief. He points out that it is a sound rule, in dealing with vital organs, that only a minimum amount of interference should be had recourse to, and that this is especially necessary in cases which threaten pulse-failure. The tapping should be repeated rather than too much fluid be drawn off at once.

* Chloroform or A.C.E. mixture will be the wisest, especially if pleural effusion co-exists, on account of the greater struggling with ether. Local analgesia (pp. 652 and 868) should certainly be tried.

be made downwards and outwards, and if time admits, the cut edges should be sutured to the lips of the wound. If the patient's condition admits of it, where the fluid is foul or where there is reason to suspect the presence of flocculent masses, and only in these cases, irrigation, *e.g.*, with sterilised saline, dilute carbolic acid or mercury perchloride solutions should be employed. But this must be done very gently, escape of all the fluid must be ensured—to ensure this two tubes should be inserted; finally the fluid used must be warmed. Any opening in the pleura should be closed with a stitch, or gauze secured with silk.

If, as is not uncommon, an empyema be present, the critical condition of the patient will usually render it advisable to defer further operation for a day or two.

On the subject of the best incision for drainage of the pericardium, two very instructive papers by Mr. T. P. Rowlands (*Brit. Med. Journ.*, Jan. 2, 1904, and Apr. 15, 1905) should be consulted. The cases, aged $2\frac{1}{2}$ years and 1 year and 8 months respectively, were under the care of Dr. Coutts at the East London Hospital for Children: his remarks on purulent pericarditis and the complications which may, as in these cases, be present, will repay careful study. In the second of the two papers mentioned above, and in a letter to me, July, 1906, Mr. Rowlands is of opinion that removal of the seventh left costal cartilage from near its chondro-costal junction to within an inch of the sternum, together with a portion of this bone, if needful, gives the easiest, widest, safest mode of access and the best drainage. When the thorax is opened the diaphragm is pushed downwards, and never need be separated or pierced. The pleural margin can be pushed up and outwards, and the pericardium opened and drained at its lowest and outermost point, so that when the patient is turned on one side the pus drains away better than with an incision close to the mid-line, which is also more liable to trespass on the abdomen and the deep epigastric artery. It is also possible to pass a finger into the various recesses of the pericardium, and to introduce a tube behind the heart into the oblique sinus with comparative ease.

Epigastric route.—This method, first brought forward, I believe, by Larrey, was strongly recommended by the late Mr. H. W. Allingham (*Lancet*, June, 1900), on the ground that the pericardium is thus incised at the lowest part of its anterior wall. Stated very briefly, this operation consists in incising the left rectus abdominis, and after avoiding the peritoneum, opening up the cellular interval between the sternal and costal fibres of the diaphragm (in which lies the superior epigastric artery), and thus exposing the lowest part of the pericardium. A good account of this method of reaching the pericardium is given by Mr. Pendlebury (*Lancet*, Mar. 10, 1900, p. 693), with a successful case. The collection here was serous. Mr. Rowland (*Brit. Med. Journ.*, Jan. 2, 1904), considers that the above ingenious operation has the following drawbacks: (a) The little room available in most adults, who have wide, firm, or even ossified ensiform cartilages and rigid costal cartilages; the costo-xiphoid space is too narrow in these cases. (b) The operation is necessarily performed somewhat in the dark and under cover of the sternum and seventh costal cartilage, and it is not easy to be sure whether the exploring finger is above or below the diaphragm, especially by an operator not quite familiar with the anatomy of this region. For these reasons a portion of the seventh, or even of the sixth, costal cartilage, may have to be removed in order to provide the necessary room, as practised by Mr. Allingham and Mr. Pendlebury. (c) The superior epigastric artery may be wounded as it comes through the diaphragm, and cause troublesome hæmorrhage in the depth of the wound. (d) The

pericardium may be separated by the finger from the parietes, and pus may then leak into the loose connective tissue and set up a fatal mediastinitis. When the pericardium is much distended these dangers and difficulties are diminished; the reverse will be the case where the collection of pus is small. In the second case related by Dr. Coutts and Mr. Rowlands the amount was between one and two ounces.

During the first few days after the operation the drainage of the cavity may be materially assisted by keeping the patient propped up, and turned on to his face at intervals as much as possible.

Causes of Failure.

1. The tissue of the heart degenerated, or the organ dilated. These changes may come on very rapidly.

2. Toxæmia, septicæmia, and pyæmia.

3. Co-existing effusions into pleural and peritoneal sacs, or into joints, or pneumonia. During the after-treatment measles and bronchitis may cut short a case that otherwise promises well, as occurred in one of the children under the care of Dr. Coutts and Mr. Rowlands (*vide supra*).

4. Œdema of lung. Evidence of this should be most carefully watched for. It proved fatal in the case of a patient of Dr. Goodhart's, a young lady of 14, from whose pericardium I removed forty-six ounces of pus by an incision in the fifth right space, a little outside the sternum.

5. Co-existing diseases—*e.g.*, phthisis, or renal disease.

SUTURE OF WOUNDS OF THE HEART (Fig. 300).

Owing to the rareness of the use of the knife or revolver in this country, most of our information on this subject is derived from the Continental and American surgeons.

Apart from the recoveries that have taken place after suture, severe wounds of the heart have been almost invariably fatal. Surgical intervention has, however, undoubtedly saved a considerable number of lives, as may be gathered from the following figures:—Loison (*Revue de Chirurgie*, 1899, Nos. 1, 2, 6) collected 90 cases of wounds of the heart by cutting instruments. Of 72 cases not operated upon, 71 died; of 18 cases treated by operation, 10 recovered. Again, Hill (*New York Med. Record*, Dec. 15, 1900) gives 17 cases of heart suture, 7 of which, or a percentage of 41, recovered.

Wounds of the heart may be either penetrating or non-penetrating—the great majority of them belonging to the former class. The ventricles are more often injured than the auricles, and the right ventricle more commonly than the left. It has been shown, both by experiments upon animals and by the operations that have been performed on man, that interrupted silk sutures, passed deeply into the myocardium, produce perfect hæmostasis. The sutures should be passed—as recommended by Rehn, quoted by Ware (*Annals of Surgery*, Oct. 1899)—during diastole, since the heart sinks back during systole into the pericardial space.

Various methods have been adopted to expose the heart. A good account of many of these is given by Ware (*loc. supra cit.*). If the operative experience and surroundings of the surgeon and the condition of the patient admit of it, an osteoplastic flap such as Rotter's will give good exposure. But if the heart be wounded low down the parts may have been unnecessarily disturbed, if a large flap be adopted as a matter of routine. An incision, starting nearly one inch from the left border of the sternum, is carried along the third rib for four inches. A second one is similarly made along the sixth rib. A vertical incision along the anterior axillary line connects the first two. The third, fourth, and fifth ribs are cut through with the pleura along the line of the third incision, and the

musculo-osseous flap raised and turned inwards, the cartilages of the ribs acting as hinges. According to the age of the patient these must be bent or divided. For an operator having to face this emergency under different conditions it would probably be advisable to adopt less complicated steps. Beginning with an angular incision along the sixth costal cartilage and over the sternum, the soft parts are raised so as to expose the fifth, sixth, and probably the fourth costal cartilages. These are removed according to the steps already given (pp. 869, 891), by cutting through the corresponding ribs and severing the cartilages about three-quarters of an inch from the sternum. The triangularis sterni and internal mammary vessels are dealt with, and the pericardium recognised by the directions given at p. 891. If, as is probable, the pleura has been wounded, all that is needed at this stage is to separate it sufficiently from the pericardium. This is next opened by a flap or a  shaped incision, made freely so as to give access to the anterior aspect of the heart. Clots are gently wiped away with gauze wrung out of sterile saline solution, and the wound in the heart found and sutured with fine silk or catgut. Both of these last two steps may be interfered with by the tumultuous action of the struggling organ. Introduction of two or three fingers of the left hand, or that of an assistant, behind the heart will help to steady it; but while the insertion of the little finger into the wound, and temporary "traction" sutures of stouter silk may be found necessary, it is more than possible that such steps may turn the scale against the heart which is on the point of ceasing to beat. The introduction of the sutures should be sufficiently deep to prevent their tearing out, but should not enter the endocardium;* the coronary vessels should be carefully avoided. If the wound should be high up, the third rib and part of the sternum must be removed. It is never safe to close the wound in the pericardium, which should be drained with gauze. While any fluids, clots, &c., which are accessible should be removed from the pleura, time should not be taken up in attempting to cleanse this sac. It is blood that will be chiefly present, and this should, for the present at least, be left to the pleura to deal with. It need scarcely be added that every possible precaution against shock should be taken before, during, and after the operation, including the injection of sterile saline fluid into the veins and cellular tissue (p. 141). Many other hints will be gathered from the cases of wounds from bullet and knife which follow.

The following most striking case of double gunshot wound of the heart was operated upon by M. Launay, and reported by M. Peyrot (*Bull. de l'Acad. de Méd.*, July 29, 1902):—

The operation took place about three hours after the injury. The pulse was now uncountable, but the patient was able to give an account of the injury. The external wound was at the nipple, and from it hæmorrhage was small and intermittent. The heart sounds were indistinct, a splashing sound could be heard, and there was evidence of blood in the pleura. Chloroform having been administered, an osteoplastic flap was turned back, with parts of the fourth, fifth, and sixth ribs. Complete pneumothorax was present, with a large amount of blood in the pleural sac. The thin edge of the lung was perforated by the bullet. From a small wound in the pericardium the blood flowed slowly and persistently. The wound being enlarged, one was found in the left ventricle, 2 cm. from the apex. From this bleeding took place, only in diastole. The wound was easily closed with a catgut suture. Examination of the back of the heart was somewhat difficult, but the wound of exit was found when the finger was placed under the apex, and the heart tilted up. It was situated near the base of the left apex. A traction-suture was placed in the heart muscle in order to give access to this wound, which was closed with two catgut sutures. The pericardium was cleared of clots and partially closed. The pleura was treated in the same way. During the operation two litres of salt solution were injected into the subcutaneous tissue. The operation lasted about thirty-five minutes. The pulse was uncountable throughout, but the heart had never ceased to beat. The next day the patient was in good condition. P. 100 to 120, of good

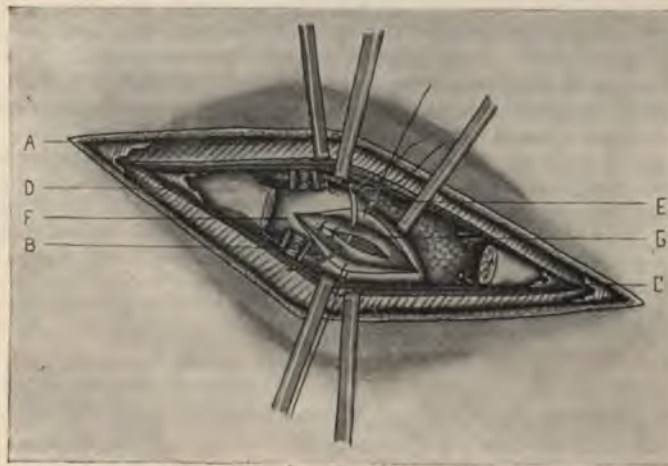
* If the wound has involved one of the muscoli pectinati or the septum, it may be only possible to close the superficial part.

volume. The drains were removed forty-eight hours after the operation. The patient made an excellent recovery.

The following account of a successful case of a stab-wound dealt with by Parrozzani, is given by Hill (*loc. supra cit.*):—

"Parrozzani, in 1897, operated upon a young man who had been cut three times. Two of the cuts were of no importance. He followed his assailant thirty steps, and fell. Five hours after the injury he was carried to the hospital, where it was found that the dagger had entered the seventh left intercostal space in the mid-axillary line. His general condition was extremely grave, heart-beats and pulse almost imperceptible, and respiration rapid and superficial. Immediate intervention without an anæsthetic was decided upon. An incision through the soft parts, an inch and a quarter from the margin of the sternum, in the fourth intercostal space, was carried for a distance of five inches and a half, then it descended vertically in the mid-axillary line as far as the superior margin of the ninth rib. The fifth, sixth, seventh, and eighth ribs were cut

FIG. 301.



Exposure of pericardium and heart by partial excision of left fifth costal cartilage:—A, Pectoralis major muscle retracted, overlying the retracted intercostal muscles and membrane; B, Internal mammary vessels; C, Intercostal vessels; D, Sternum and part of fifth costal cartilage; E, Pleura and lung retracted; F, Pericardium, incised and margins retracted; G, Heart, showing incised wound being sutured. (Bickham.)

through in the mid-axillary line with the pleura. The musculo-osseous flap was raised, with the cartilages of the ribs acting as the hinges. The pleural cavity was filled with blood, and an opening one inch in length was found in the pericardium, which was subsequently enlarged to two inches and a half. There was very little blood in the pericardium, because the injury was in the most dependent part, and the blood readily escaped into the pleural cavity. A wound in the apex was observed, three-quarters of an inch in length, through which the little finger was passed into the left ventricle. This served the double purpose of checking the hæmorrhage and steadying the organ for the introduction of the sutures. Four deep silk stitches were used, not touching the endocardium. Passing the needle caused violent throbbing of the heart. The pleura and pericardium were thoroughly cleansed, and the flap was sutured in position. Stimulating hypodermic injections were used, and hypodermoclysis and auto-transfusion practised. The operation lasted one hour and a quarter. Recovery resulted."

Hill, of Montgomery, Alaska, records (*New York Med. Rec.*, 1900, vol. lviii. p. 921) a successful case of suture of a stab wound of the left ventricle in a negro, æt. thirteen. The operation was performed eight hours after the injury, under chloroform, the wound being closed with one catgut suture. The patient made a good recovery.

The following are the conclusions drawn by Hill, together with others from the different published cases :—

1. As the operation has reduced the mortality from about 90 per cent. to about 63 per cent., every wound of the heart should be operated upon immediately.
2. Unless the patient is unconscious, and corneal reflex abolished, an anæsthetic, preferably chloroform, should be given. Struggling is liable to cause detachment of clot, and fresh hæmorrhage, as occurred in Parlavacchio's patient.
3. The wound should never be probed, for fear of injury to the myocardium.
4. Rotter's flap-operation (p. 893) renders access to the heart extremely easy, and should usually be adopted.
5. Before sutures are introduced the heart should be steadied either by lifting it up with the hand, or if the wound be large enough, by introducing the little finger into it, as Parrozzani did, which serves the further purpose of stopping the bleeding.
6. The sutures should be of reliable catgut or fine silk, always interrupted and introduced with the smallest possible needle. They should not involve the endocardium, and as few as possible should be used consistent with safety, as they cause a degeneration of the muscle, with a tendency to dilatation and rupture.
7. Suturing or any other part of the technique should not be discontinued because the heart has ceased to pulsate, especially if respiration continues.
8. Forcible divulsion of the sphincter and squeezing the heart have been recommended as means of resuscitation: how far they are beneficial is another matter.
9. The pericardium should be cleansed by sponging out, no fluid being poured into the sac.
10. The advice to close the pericardium does not seem judicious. In Rehn's case, evidence of compression appeared, necessitating re-opening the wound and drainage.

In the majority of cases the wound was situated in front, and the pericardium was usually found to be distended with blood. The length of time between the injury and the operation has varied considerably: in a successful case by Rehn it was more than twenty-four hours; in a case of Giordano's, in which the left auricle was sutured, the operation was performed within half an hour of the receipt of the injury. In the majority of the cases some hours elapsed before the operation.

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